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ANGUS LOCOMOTIVE & CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

II.

GENERAL CHARACTER OF THE BUILDINGS.

(*For previous article see this journal, December*, 1904, *p.* 451.)

The buildings are excellent throughout. They are substantial, serviceable, free from "frills" or wasteful attempts at ornamentation, and are well adapted to their purposes. The buildings, as well as their arrangement, reveal most careful engineering work. Their construction will precede their functions and interior arrangement in this description. In the following table the areas and proportions are given. No account is taken of sheds and lavatories, the latter being generally built upon the larger buildings as lean-tos.

AREAS AND PROPORTIONS.

	Sq. Ft. Area.	Percentage.
Locomotive shop	190,384	22.6
Grey iron foundry	41,724	4.9
Pattern shop	8,200	1.0
Pattern storage	7,500	.8
Car machine shop	37,440	4.4
Truck shop	35,588	4.2
Freight car shop	57,780	6.9
Wheel foundry	24,039	2.9
Frog shop	26,928	3.2
Blacksmith shop	84,082	10.0
Power house	17,976	2.1
Planing mill	63,000	7.5
Dry kilns	9,350	1.1
Cabinet and upholster shop	53,940	6.4
Passenger car shops	134,400	16.0
General stores	50,490	6.0
Total	842,821	

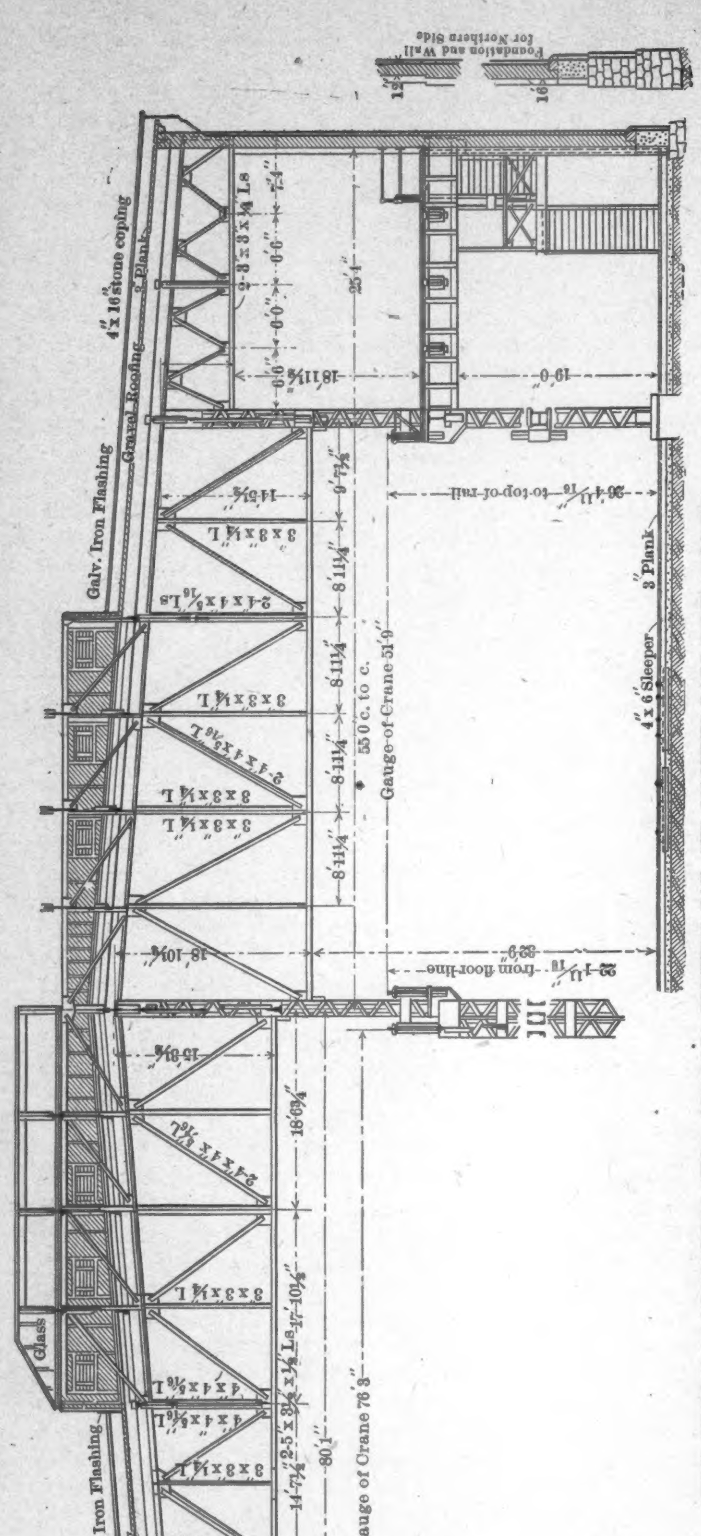
The buildings with the largest spans were built with steel trusses, but the smaller ones are of slow-burning construction, using wooden roof trusses, except in the truck shop, where a portion of the roof is supported by 20-in. I beams. Small lean-to additions have been applied to the main buildings, to provide for lavatories, shop offices and fan rooms. The shops, as a rule, are unusually well provided with natural lighting, the windows are high, and cover about half of the wall area, and the skylights about one-quarter of the roof area. The windows are all provided with 10-oz. clear glass, in 10 x 16-in. panes. The blacksmith shop and foundry buildings have clere story windows, and the other shops are, as a rule, lighted with monitors 12 ft. in width, arranged transversely, and with roofs pitched both ways, fitted with ⅜-in. rough, German, roof glass.

The foundations of nearly all of the buildings are very deep, owing to the nature of the ground, and the amount of filling which was required. About $80,000 is buried in the foundations, which are carried to rock through soft clay. Some of the foundations are 20 ft. in depth. They are built of rough, flat stone, surmounted by walls of rubble masonry 27 ins. thick, extending to within 1 ft. of the level of the ground. A course of concrete surmounts these walls, and reaches about 2 ft. above the level of the ground, finishing in a course of cut stone, upon which the brick walls are built. The walls are 12 ins. thick at the top, and from 12 to 20 ins. thick at the bottom. In nearly all cases they carry the weight of the roof. Pile foundations were used for the cabinet shop, pattern buildings, general storehouse and frog shop. All the rest are on concrete and rubble. Steel roofs are used for the blacksmith shop, the foundries, the power house and the locomotive shop. The construction of the roofs of the buildings constitute an important feature of the plant, to which adequate space cannot be given in this article. Another important feature is the large use of wood, which reflects the opinion of underwriters as favoring wood to steel for such construction. The roofs slope 1 in 12, and are built of 3-in. plank, covered with tar and gravel. They are built with 10-ft. spans, as a rule, and in accordance with the underwriters' standard specifications for slow-burning construction. Roof loads were figured at 70 lbs. per ft., allowing 50 lbs. per ft. for snow load and 20 lbs. for the roof itself. There is no exposed woodwork outside of the buildings except window and door frames.

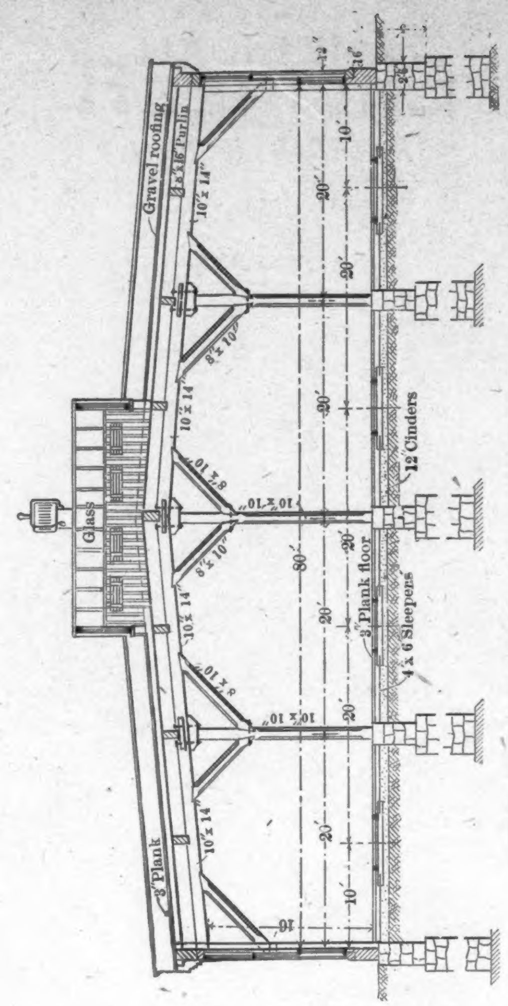
The floors are usually of concrete or cinders, tightly rammed, except those which are planked with 3 x 10-in. lumber laid on 4 x 6-in. timbers. The foundries and blacksmith shop have floors of clay and cinders, 12 ins. thick, rammed to a hard surface.

Locomotive Shop.—The interior of this building will receive special attention later. It is arranged in three spans, the main span of 80 ft. for the erecting floor, a span of 56 ft. for the machine shop, which is served by cranes, and a span of 25 ft. under the gallery, which extends the full length of the building. The walls of the building are 48 ft. from the ground to the eaves, and the building is divided lengthwise into panels of 22 ft., which is the distance between the roof trusses. Each space has two 12-ft. windows, 16 ft. high; the windows are in three sections, the middle of each is fixed, and the others arranged to open. Each roof panel has a transverse monitor 12 ft. wide by 72 ft. long, each having ventilating doors on each side and a rotary ventilator at each end. The steel skeleton is independent of the walls. The general character of the columns and roof trusses is shown in the engravings. The 60-ton cranes are carried on plate girders 50 ins. deep. The girders for the machine shop cranes are 36 ins. deep. The construction of the trusses of the columns for supporting the roof trusses and the crane girders is illustrated in the engravings. This building occupies 190,384 sq. ft., and 2,700 tons of structural steel were required in its construction.

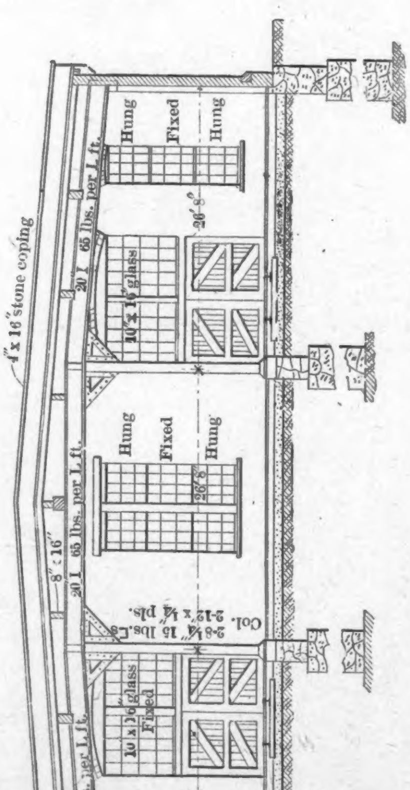
Iron Foundry.—This building is 122 x 342 ft., and stands next to the locomotive shop. It has a 60-ft. main bay and two side bays of 30 ft. separated by the roof and crane columns. This is a well-lighted building, with half of the side walls lighted by windows, and the roof has a monitor 22 ft. wide, reaching nearly the entire length of the central bay. The moulding is done in the main bay, the flask and core makers, the sand, blower and tumbler rooms, the offices and cupola occupy the north bay, a coke storage bin and a heavily con-



CROSS SECTION OF LOCOMOTIVE SHOP, SHOWING ERECTING BAY AND MACHINE BAYS WITH GALLERY.

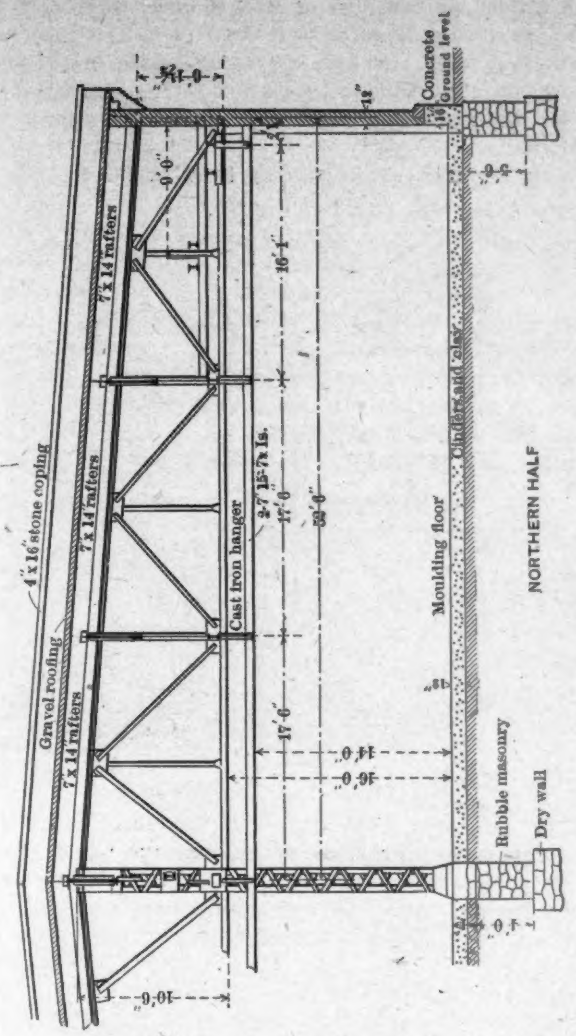


SECTION THROUGH ERECTING END OF TRUCK SHOP, SHOWING FOUR BAYS.

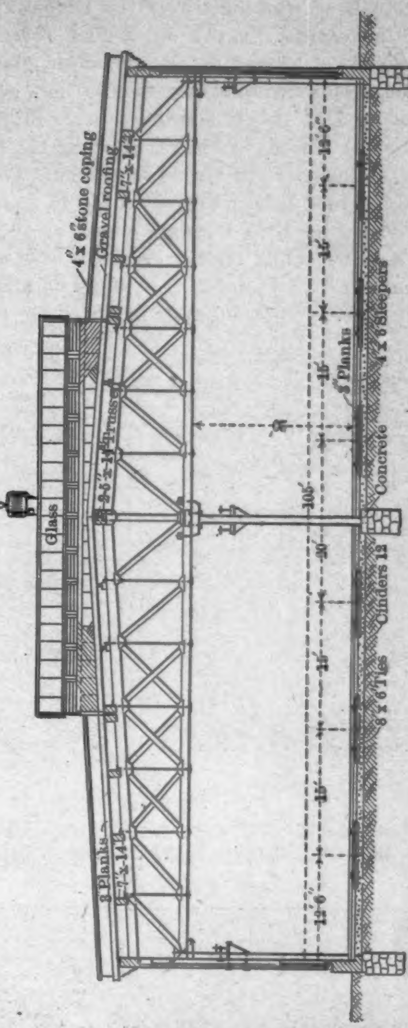


SECTION THROUGH MACHINERY END OF TRUCK SHOP.

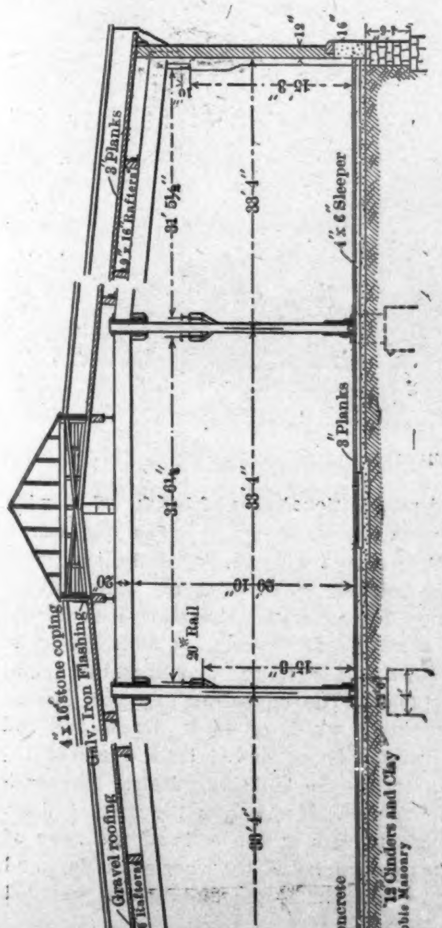
ANGUS LOCOMOTIVE AND CAR SHOPS—CANADIAN PACIFIC RAILWAY.



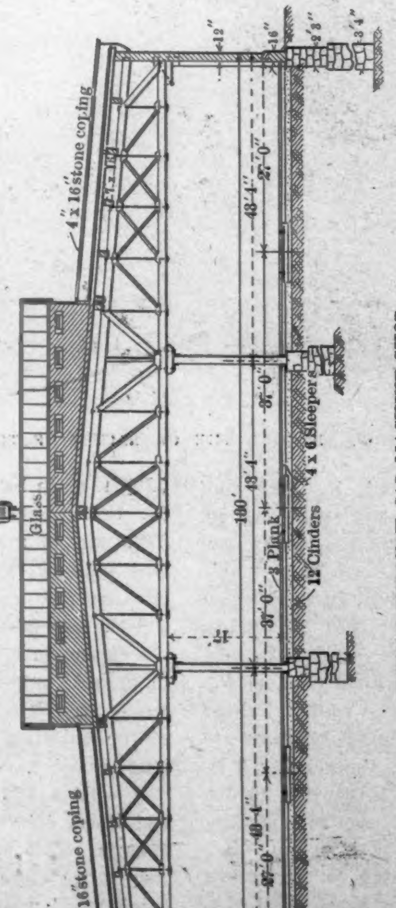
HALF-SECTION OF WHEEL FOUNDRY.



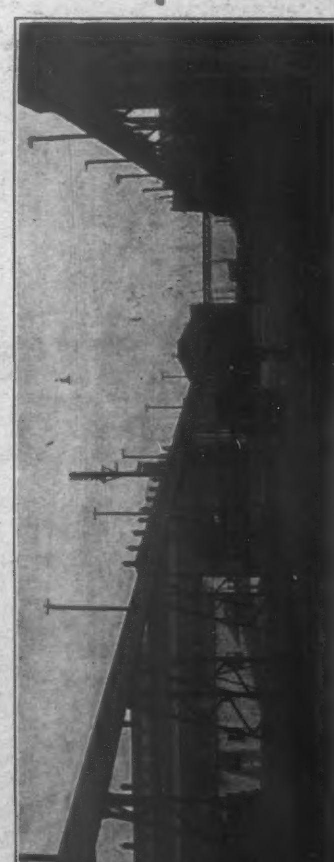
SECTION THROUGH FREIGHT CAR SHOP.



SECTION THROUGH FROG AND SWITCH SHOP.



SECTION THROUGH CAR MACHINE SHOP.



MIDWAY LOOKING SOUTH, SHOWING CRANES.

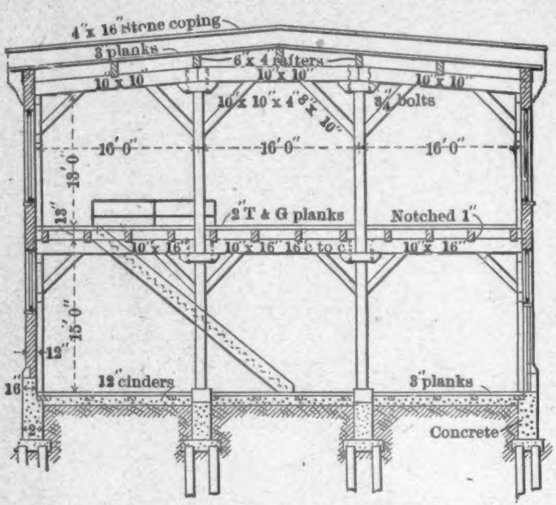
ANGUS LOCOMOTIVE AND CAR SHOPS—CANADIAN PACIFIC RAILWAY.

structed charging floor was built over the cupola room. The charging floor is reached by the out-of-door foundry crane, whereby supplies are delivered to the projecting platform.

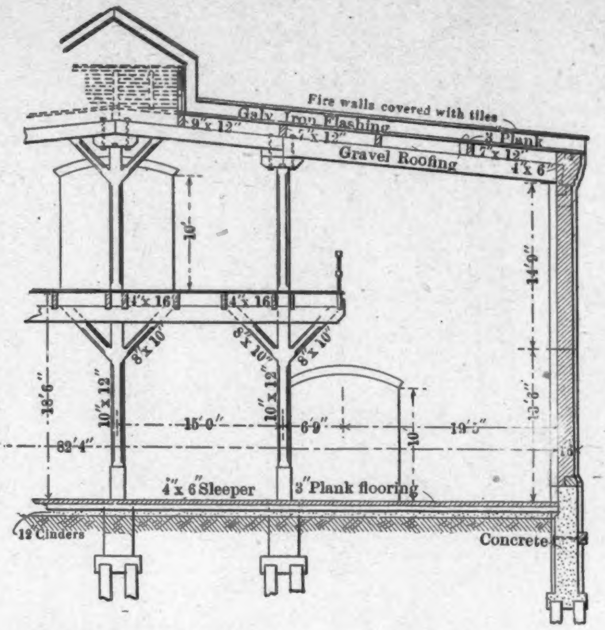
Pattern Shop.—This building has two stories, occupying a ground space of 50 x 82 ft. The building is of brick, and the roof is supported by wooden columns, dividing the floor space into three bays, as indicated in the cross section. The patterns are stored in a fireproof building of 100 x 150 ft. floor area, the roof being supported by 20-in I beams placed at 15-ft. centers, carried on the side walls and resting on a row of steel columns through the center. This building is of concrete and fireproof.

Car Machine Shop.—This building is 130 x 288 ft. and has being divided by two rows of steel columns carrying 24-in. I beams, as roof girders, at 24-ft. centers. The shop has a longitudinal track and 2-ton travelling cranes in two of the 33-ft. spans. The windows are 8½ x 15 ft., with 3-ft. spaces between, the roof being lighted by a longitudinal monitor 15 ft. in width.

Wheel Foundry.—This building is 107 x 187 ft., with two



SECTION THROUGH PATTERN SHOP.



HALF-SECTION OF STORE HOUSE, SHOWING BALCONY.

LOCOMOTIVE SHOP, SHOWING THE CHARACTER OF THE BUILDING.

three standard gauge tracks running through it. The roof trusses of this building are illustrated in the cross section. The floor is of plank, laid flush with the rails of the tracks, and built on a bed of cinders 12 ins. deep. The roof is of wood.

Truck Shop.—This building is 82 x 434 ft. Three rows of wooden columns divide the eastern portion into four 20-ft. bays, and these support wooden roof girders, each 24-ft. centers. The west end has three bays and two lines of steel columns carrying the roof on steel I beams. The roof is lighted by 10 x 20-ft. monitors in each panel. The side windows are 8½ ft. wide x 12 ft. high, the space between them being 3 ft. The erecting track for trucks is provided with two pits 15 ins. deep and 18 ins. wide, outside of the rails, to facilitate putting the trucks together.

The Frog and Switch Shop.—This building is 102 x 264 ft. It is a special manufacturing plant for frogs, switches, switch stands, and kindred manufacturing. It has three bays, 52½-ft. main bays and an additional area of 148 ft., 27 ft. wide, for the cupolas, blowers, core and store rooms and offices. This part of the plant is shown with special pride, because it was planned with the sole object of efficiency, and without stinting the expenditure in any way. The floor area is well lighted by eight 9-ft. monitors, 53 ft. long. A 90-ft. length of the extension for the cupolas is carried to two stories in height to provide a charging floor. The annealing pits and storage space for wheels occupies a width of 40 ft. across one end of the building, this portion being served by a crane of 1½ tons capacity, running across the building. Hoists for handling wheels and flasks are arranged across the casting floor, and these deliver wheels to cars at the ends of the rows of moulds. This plant has a capacity of 300 wheels per day, and very large storage space outside of the building is provided for finished wheels.

The Freight Car Shop.—This building is a manufacturing

plant for freight cars; it is 107 ft. wide x 540 ft. long, with six tracks from end to end. For overhead lighting transverse monitors, 10 x 48 ft. in size, are located in each panel of 20 ft. The roof trusses are carried on steel columns, which also support runway girders for three 2,000 travelling air hoists in each bay.

BLACKSMITH SHOP.—This is one of the finest railroad blacksmith shops ever built It is large and light, and well arranged. The shape of this building is due to the desire to bring the work for the car and locomotive departments into the same building, in an arrangement which would be conveniently accessible to the locomotive and car shop buildings. As the heaviest work is required on the locomotive side, this portion is the longest. Considered as two rectangular buildings, this shop occupies space 303 ft. 8 ins. x 146 ft. 4 ins. and 304 ft. x 130 ft. 8 ins. Its greatest length on the west side is 434 ft., and on the north side 304 ft. The lengths of the inside walls of the "L" are 157 ft. 8 ins. and 303 ft. 8 ins. The two portions of the building are divided into three bays by two longitudinal rows of columns. The roofs over the central bay are higher than those of the side bays, giving clere story light. A monitor 14 ft. wide extends nearly the full length of each central bay.

STORE-HOUSE.—This is a specially well arranged building. It occupies 85 x 594 ft. of ground area, and has brick walls. It has three rows of wooden columns supporting the roof and also supporting a platform, which does not extend the full width of the building, but forms a gallery for the storage of light articles. Elevators furnish facilities for handling this material, and the gallery windows are 13 ft. 6 ins. above the floor, leaving ample space below for the construction bins. A 12-ft. monitor extends the full length of the building, lighting the gallery.

DRY KILNS.—The soft wood dry kiln is built in four compartments, each 19 x 85 ft. The hard wood kiln has one compartment of this size and one of the same length, but 21 ft. wide, and these were equipped with the Morton system by the A. H. Andrews Company of Chicago. The kilns are of brick with division walls of wood roofed with gravel. The end openings are covered by canvas doors, operated by rolling up, this taking the place of end walls. The location of these kilns was shown on the general plan illustrated in the December number of last year.

The remaining buildings, drainage, fire protection and heating systems will be described next month.

FROG SHOP, SHOWING LONGITUDINAL SKYLIGHT, AND LOCOMOTIVE SHOP WITH TRANSVERSE SKYLIGHTS TO THE RIGHT.

FREIGHT CAR SHOP, SHOWING CHARACTER OF CONSTRUCTION OF BUILDING AND ROOF.

FREIGHT AND PASSENGER LOCOMOTIVES.

NORTHERN PACIFIC RAILWAY.

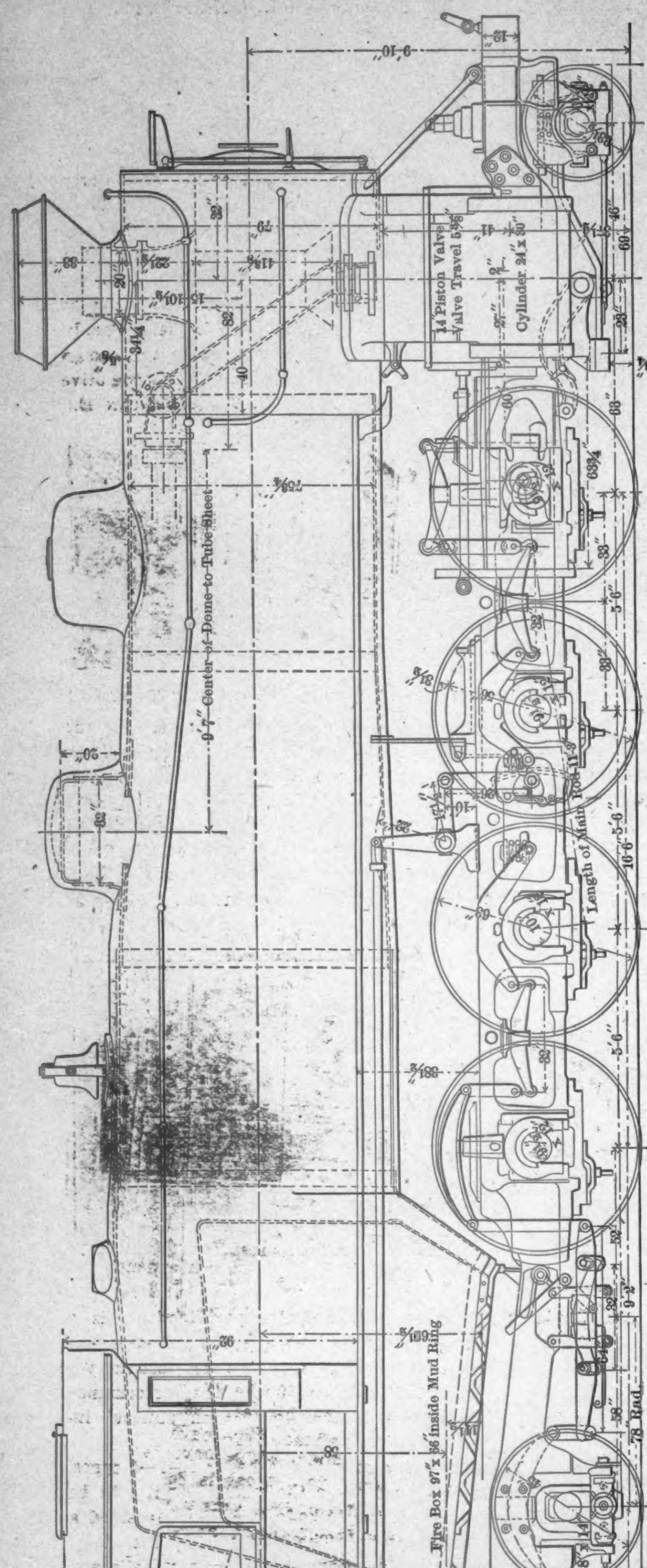
2—8—2 MIKADO TYPE.

The Northern Pacific Railway has added to its heavy freight equipment 25 very heavy 2—8—2 type freight locomotives, 19 of which are simple piston valve engines with 24 x 30-in. cylinders, and 6 are tandem compounds, the general features being the same for both types. The simple engines are illustrated by the accompanying engravings. These locomotives weigh 259,000 lbs., with 196,000 on driving wheels, which is heavier than any previous design for the Northern Pacific. Readers will be interested in comparing these in the design with that of similar type built by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fe (AMERICAN ENGINEER, 1903, page 16). The weight of the Northern Pacific engines is not quite as great as that of the Santa Fe, and the heating surface is 4,000 ft. for the Northern Pacific as compared with 5,366 sq. ft. for the Santa Fe; the latter being next to the largest ever used on a locomotive. It is in the design of the boiler that the greatest interest in the new Northern Pacific locomotives centers, because this boiler marks a radical step toward increased facility of circulation of water at an expense of both grate area and heating surface.

Mr. David Van Alstyne, mechanical superintendent, is a leader in providing ample steam and water space and abundant room between the tubes for circulation. As these locomotives are to work in a district of very bad water, the performance of these new locomotives will be watched with unusual interest.

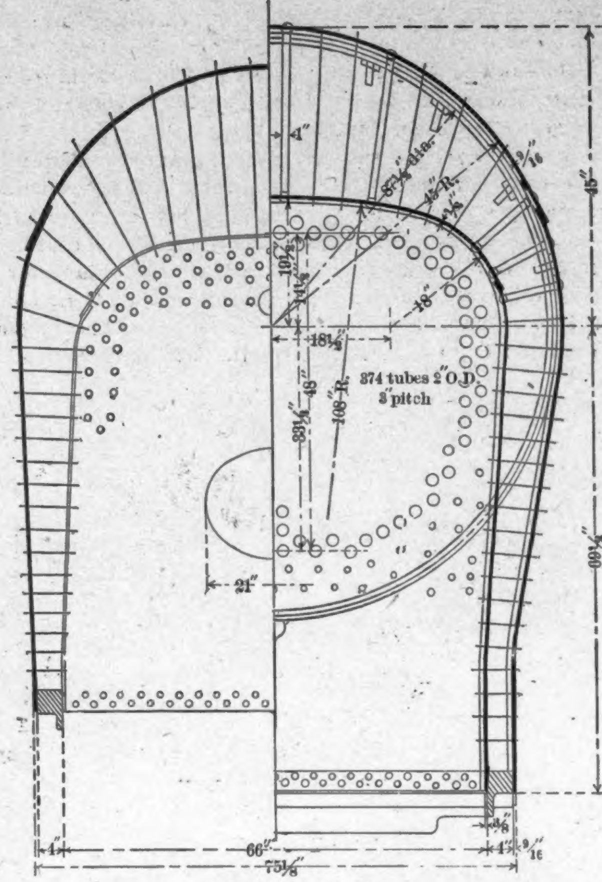
By comparing the new design with the heavy 2—8—0 types, put into service on this road since the year 1900, it will be observed that the boilers of the Mikado type have received a great deal of careful attention. The throat is 26 ins. deep, which is very unusual for a locomotive with a wide grate, and this constitutes a strong argument in favor of the 2—8—2 in preference to the 2—8—0 type.

The distance from the crown to the roof sheet is nearly as great as the depth of the throat. The steam dome is placed in a second sheet from the front of the boiler; the last ring of tubes in the back tube sheet is kept well away from the shell; the water spaces at the mud ring are 4½ ins. in front and 4 ins. at the sides and back; the water space at the throat

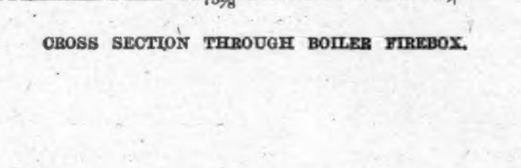


FREIGHT LOCOMOTIVE, 2—8—2 (MIKADO) TYPE—NORTHERN PACIFIC RAILROAD.

DAVID VAN ALSTYNE, *Superintendent of Motor Power.* AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders.*

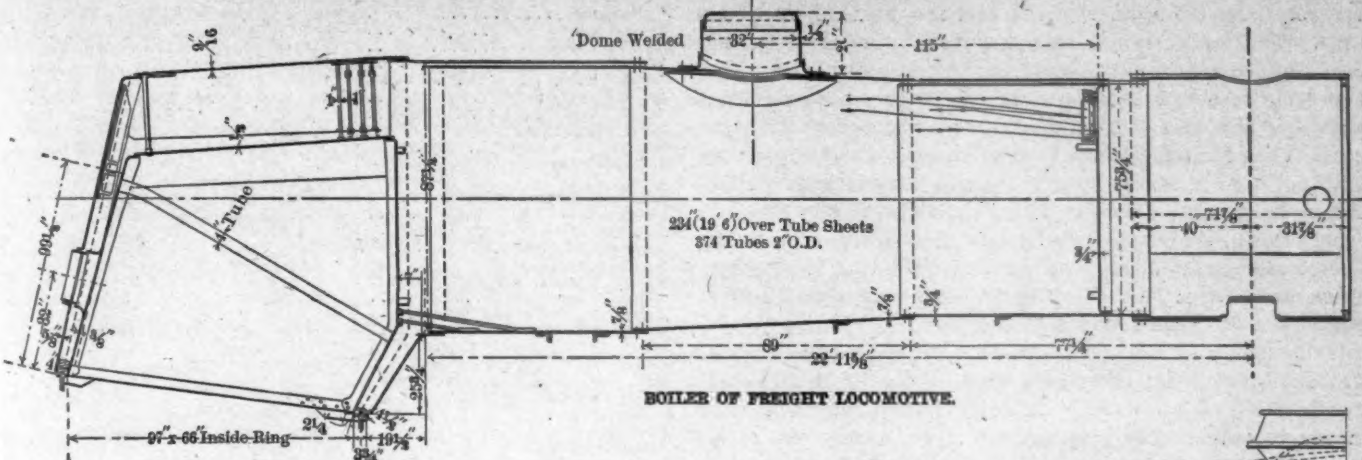


CROSS SECTION THROUGH BOILER FIREBOX.

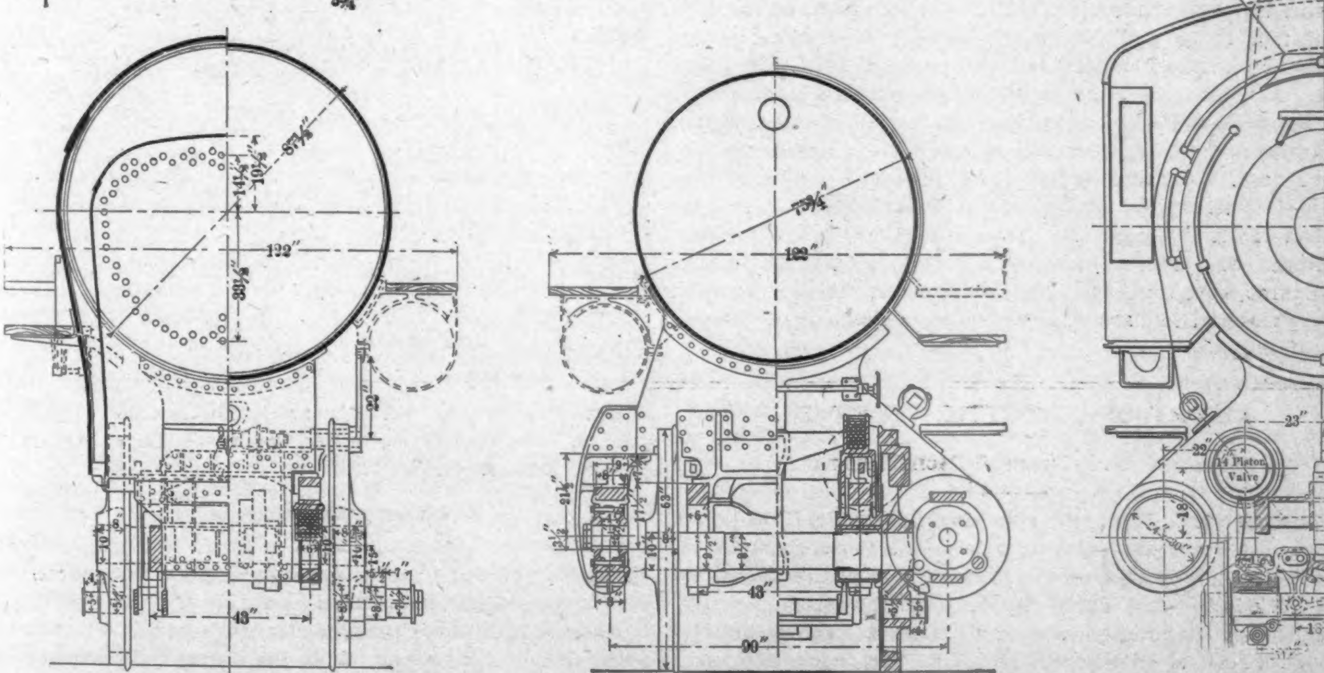


REAR ELEVATION AND CROSS-SECTION THROUGH CAB.

FREIGHT LOCOMOTIVE, 2—8—2 (MIKADO) TYPE—NORTHERN PACIFIC RAILROAD.



BOILER OF FREIGHT LOCOMOTIVE.



SECTION OF FREIGHT LOCOMOTIVE.

PASSENGER LOCOMOTIVE, 4—6—2 (PACIFIC) TYPE—NORTHERN PACIFIC RAILWAY.

DAVID VAN ALSTYNE, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS, *Builders.*

is 7 ins.; the water space at the sides of the firebox begins to widen at the fourth row of stay bolts, and furthermore the spacing of the 2-in. tubes is at 3-in. centers in both tube sheets. With this combination the boilers should not only carry their water well, but the circulation should be all that is desired, even in the bad water district between Mandan and Glendive, where these engines are to run. The grate area, 43.5 ft., is less than in recent boilers made as large as 75 ins. in diameter. All of these features are intended to enable the boiler to handle foaming water and improve the steaming qualities with the inferior grade of fuel which is available on the Yellowstone Division.

These engines are equipped with low nozzles and with diamond stacks in order to use Red Lodge coal, mined on the line of the Northern Pacific in Montana. This coal is very light and sparks very badly. For the reason that the Northern Pacific officials believe that it will prevent fires more effectively than the ordinary front end, the diamond stack was used. The stack base is extended into the smoke box and opens under a horizontal partition. The profile of the road between the points mentioned is that of a rolling country, with long stretches of 1 per cent. grade, with some of 1½ per cent. Thus far the engines have given good results, but they have not been in service long enough to justify positive statements as to performances. Mr. Van Alstyne, who has had considerable experience with tandem compounds, expects the 6 locomotives of this type to make a good showing in economy. These locomotives have tubes 19 ft. 6 ins. long and the driving wheels are placed very close together.

If the boiler of the new Northern Pacific design supplies steam adequately for these 24 x 30-in. cylinders, this locomotive is likely to influence future design in an important way. In our record of heavy locomotives there is only one other design having cylinders 24 ins. in diameter—that of the 2—8—0 type built by the Pittsburg Locomotive Works for the Bessemer & Lake Erie Railroad, illustrated in July, 1900, page 214. A number of 23-in. cylinders are running successfully on the 2—8—0 Rogers locomotive for the Illinois Central, illustrated in January, 1900, page 13; the 4—8—0 Brooks for the same road, illustrated in October, 1899, page 315; and the 2—8—0 Pittsburg locomotive for the Union Railway, described in November, 1898, page 365. The Northern Pacific engines are equipped with Player improved leading and trailing trucks and throughout the details indicate most careful design, with ample material so disposed as to reduce the liability of locomotive failures.

4—6—2 PACIFIC TYPE.

Simultaneously with the freight engines from the Brooks Works, 5 4—6—2 passenger engines were built at Schenectady and are illustrated from a photograph. This design follows the freight engines in the boiler features as to depth of throat, location of dome, large spaces between tubes (1-in. bridges at back ends and 29-32-in. bridges at the front end). The inside firebox sheets are vertical at the sides and the water spaces are the same as those of the freight engines. The passenger engines are similar in weight to the 4—6—2 type of the New York Central (AMERICAN ENGINEER, 1904, page 87).

Tables of dimensions of both freight and passenger engines are presented.

GENERAL DIMENSIONS OF NORTHERN PACIFIC LOCOMOTIVES.

	FREIGHT 2-8-2 TYPE	PASSENGER 4-6-2 TYPE
Cylinders	24x30 ins.	22x26 ins.
Track gauge	4 ft. 8½ ins.	4 ft. 8½ ins.
Tractive power	46,630 lbs.	31,000 lbs.
Wheel base, driving	16 ft. 6 ins.	12 ft. 0 ins.
Wheel base, rigid	16 ft. 6 ins.	12 ft. 0 ins.
Wheel base, total	34 ft. 9 ins.	33 ft. 0 ins.
Wheel base, total, eng. & tend.	63 ft. 1 in.	61 ft. 11 ins.
Weight, working order	259,000 lbs.	219,000 lbs.
Weight on drivers	196,000 lbs.	142,500 lbs.
Weight, working order, eng. & tend.	405,500 lbs.	347,000 lbs.
Heating surface, tubes	3,798 sq. ft.	3339.4 sq. ft.
Heating surface, firebox	200 sq. ft.	182.0 sq. ft.
Heating surface, arch tubes	9 sq. ft.	6.8 sq. ft.
Heating surface, total	4,007 sq. ft.	3528.2 sq. ft.
Grate area	43.5 sq. ft.	43.5 sq. ft.
Axles, driving journals, main	10x12 ins.	9½x12 ins.
Axles, others	9½x12 ins.	9x12 ins.
Axles, engine truck journals	6½x12 ins.	6x11 ins.
Axles, trailing truck journals	8x14 ins.	8x14 ins.
Axles, tender truck journals	5½x10 ins.	5½x10 ins.
Boiler	Extended wagon top	Extended wagon top
Boiler, outside diam., first ring	75¾ ins.	72⅛ ins.
Boiler, working pressure	200 lbs.	200 ins.
Fuel	Bituminous coal	Bituminous coal
Fire box	97x66 ins.	96x65¼ ins.
Tubes, number	374	347
Tubes, diameter	2 ins.	2 ins.
Tubes, length	19 ft. 6 ins.	18 ft. 6 ins.
Tubes, gauge	No. 11	No. 11
Engine truck	Radial	4 wheel swing
Trailing truck	Player radial	Radial, outside journals
Exhaust pipe	Single	Single
Piston, rod, diameter	4¼ ins.	4 ins.
Smoke stack	20x42 ins.	18x20 ins.
Smoke stack, top above rail	15 ft. 10½ ins.	15 ft. x 5½ ins.
Tender frame, channel	13 ins.	13 ins.
Tank	Water bottom	Water bottom
Tank, capacity	8,000 gals.	6,000 gals.
Tank, capacity fuel	12 tons	12 tons
Valves	Piston	Piston
Valves, travel	5⅝ ins.	6 ins.
Wheels, driv. diam. outside tire	63 ins.	69 ins.
Wheels, driv. centers, diam.	56 ins.	62 ins.
Wheels, engine truck, diameter	33½ ins.	33½ ins.
Wheels, engine truck, kind	Boise plate	Boise plate
Wheels, trailing truck, diameter	45 ins.	45 ins.
Wheels, tender truck, diameter	33 ins.	33½ ins.

REPORT OF COMMITTEE ON POWER.

CHICAGO, ROCK ISLAND & PACIFIC SYSTEM.

EDITOR'S NOTE.—Under the administration of Mr. L. F. Loree a committee was appointed to undertake a thorough study of the motive power of the lines comprising what are known as the Rock Island and 'Frisco Systems, and the report, recently completed, constitutes an exceedingly important and suggestive study of the motive power problem. The committee consisted of Mr. F. J. Cole, mechanical engineer of the American Locomotive Company, chairman; Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, and Mr. Robert Rennie, mechanical engineer of the 'Frisco System.

The subject is considered in seven divisions: (a) The condition of the present power and the order of its retirement, including the present value of power to be continued in service and that recommended for retirement. (b) The possible redistribution of the power to secure segregation of engines of similar character, to reduce the number of parts to be carried in stock and the cost of repairs. (c) Changes in design of existing power that will increase its capacity and usefulness and prolong its life. (d) The designing of five standard types of engines to answer the needs of the future, considering the present condition of grades and the conditions to be provided under prospective improvements. (e) A report on the economy and use of superheated steam for locomotives. (f) A report on self-contained motor cars for branch lines. (g) A report on balanced locomotives.

VALUATION OF POWER.

This general question is very complex, requiring the consideration of many conditions and factors. In general, the cost of repairs and maintenance increases with the age, and it is reasonable to expect that the cost per mile run will be very much increased when the life of the engines is prolonged beyond natural limits. If no further improvement of design was possible, and the weight was suitable for economical service, it could be conceived possible to indefinitely prolong the life of a locomotive. As each part wore out, a new one could be applied, and the locomotive would therefore be renewed piecemeal. This process would continue until nothing remained of the original construction. Of course, this condition does not exist at present, and such a method would be extremely uneconomical. It is frequently desirable to scrap small locomotives, because of being too light for economical service. This may result from improvements in bridges, or increase of traffic, which would render it desirable to dispose of light engines before they had reached their limit of age or usefulness.

Another condition to be considered is that the demand for light power is such at the present time (and likely to con-

tinue for several years), that if the retirement is carried out on a basis of age there may be a considerable shortage of power. It would appear extremely undesirable to purchase additional light power, and every endeavor should therefore be made to prolong the life of this power, and shift around lighter engines from other parts of the road, in order to fill the demand, and to generally resort to every expedient to avoid purchasing new light engines. Additions to power should be made of the heavier classes. It would seem permissible where the machinery is sufficiently heavy, and its condition generally good, to maintain these light engines, which are absolutely essential for economical performance, by renewing some of the boilers and fireboxes up to the limits of some predetermined expenditure, based upon a percentage of the original cost.

On the other hand, it is well known that repairing and rebuilding of power, which is by no means up to modern requirements, is on some railroads carried far beyond the limits of economy. Instances of this may be cited on other roads, where the cost of such work amounts to from 50 to 60 per cent. of the original cost, and is out of all proportion to the benefit derived. Boilers with greater heating surface and higher steam pressure are often applied to engines with light machinery, thus overloading bearings and over-straining the working parts. This invariably results, sooner or later, in a large increase in engine failures, due to the breakage of parts, and while the efficiency of the engine may be temporarily improved, the cost of repairs per running mile is very much increased.

Recommendations for the valuation and scrapping of equipment are based generally on a life of 20 years, and 5 per cent. annual depreciation from the original value (less the scrap value) for all serviceable heavy power. Generally speaking, engines of 20 years of age and over are recommended for scrapping when they require repairs costing over a certain percentage of the original value, as referred to later on. If the boiler has been renewed, the date of renewal should be ascertained, as a new boiler would probably prolong the usefulness of the engine for a period not exceeding fifteen years; but in no case do we recommend that the life of an engine be considered as over 30 years. Before a new firebox is applied to an engine 17 or 18 years of age, the boiler of which has not been renewed, a careful examination should be made of the boiler, and its general conditions regarding corrosion, cracks, patches, etc., ascertained, to see if the expenditure is justified, as the renewal of boilers on engines of this age is not recommended as a regular thing. Because of the present demand for certain classes of light power, the expenditure for boiler renewals may be justified on account of heavy machinery and good condition of frames, cylinders and running gear.

Depreciation is based on the value when new, taken at the actual cost of the engine. When this cannot be obtained it should be estimated or assumed at a certain arbitrary price per pound, according to the weight and type, the value in the latter case to be based on the weight in working order. The water in the boiler and the weight of the fire will approximately offset the scrap value of the tender. The value of scrap is estimated at an average price per pound which would be realized if the material is used or sold, this price to include the cost of cutting up. The present value of engines recommended for scrapping is taken at ¾ cent per pound of the engine only in working order.

(The method used by the committee in estimating the value of a locomotive at any age from one to twenty years, together with tables and diagrams for estimating the depreciation, will be presented next month.)

(*To be continued.*)

ORGANIZATION AND OPERATION OF A RAILROAD BLACKSMITH SHOP.

By A. W. McCaslin.

The well-organized railroad blacksmith shop of to-day will, in many respects, show quite a departure from the railway smith shop of a few years ago. The foreman capable of organizing this shop and satisfactorily meeting the demands at the present time, will be a good mechanic, with a thorough knowledge as to what will constitute a perfectly organized system in his particular shop. He will be acquainted with the merits of the most perfect forge, as well as the demands for and the possibilities as to output of furnaces, steam hammers, shaping machines, etc. He should have some inventive ability, that he may devise the necessary tools for the hammers and machines, which have nothing to their credit but latent power. Should he be incapable of designing or making the many tools suggested by the many different articles he is daily called upon to produce in large numbers, this power will be valueless and will occupy shop space needed for the extra number of men required to meet the demands made upon his department. This inability, or as we sometimes think, indifference, is frequently and justly the cause of his being superseded by some one who is capable of making the necessary tools to increase the output in keeping with the times. We find this qualification more essential in the foreman smith than in the foreman of any other department.

When machines are purchased for the other departments, they are generally accompanied with tools for many purposes. But it appears if the foreman smith is furnished with striking and pushing power, it is about all he is entitled to, and the utilization of this power to advantage and profit to his company and credit to himself and men frequently causes a lone seance in his endeavor to materialize imaginary movements. Should the foreman be capable, yet without privilege, or expected to draw his ideas, designs and blue prints of the necessary tools to expedite the work, from the office of those higher in authority than himself—which we believe is a pet rule on some railroads at this time—the output will suffer equally, if not worse, and the cost of production be greater than with the incompetent foreman with full privilege to do his best. We should never hesitate to spend one dollar of the company's money on tools if we can guarantee one hundred dollars in return. If the tool be a proper one for the purpose intended, this seemingly high percentage in favor of the tool or machine output against the production by hand will invariably be realized. The shop should have a sufficiency of the power and furnaces referred to, and a blast pressure of 14 to 15 ozs. per sq. in. The advantage of this pressure is a greatly increased output against that produced with a pressure of 6 or 7 ozs. as used in some shops, which, with their consequent output of only about 50 per cent. of what it should be, grants the workmen a legitimate excuse for it.

The foreman should consider well his appointments of men best qualified to produce the work assigned them. For instance, the man operating the large fire should be a first-class mechanic, who understands perfect heating and the making of heavy forgings. The men on the lighter fires, as well as those working on machines, should be placed and rated on down to the apprentice boy, according to their ability, aptness, etc. The tool dresser should be a wideawake, thinking man, with experience in the treatment of steel, interested in his work, and he should not be urged faster than the best treatment of the steel will permit. While he may forge and dress the high speed tools, he has not sufficient time to properly harden and keep the run of this grade of steel. This, in connection with the hardening and tempering of all taps, reamers, milling tools, etc., is the special duty of another.

When the shop is perfectly organized on conditions equally favorable to the employer and employe, the following are the paramount requisites in its operation: System, discipline, a consideration and fair treatment given the men recognized by them to be just, and a satisfactory proof to them that the foreman is familiar with what constitutes one hour's work, or a full day's work, in any and all work given them to do. This fact established and well understood by the men, and kept alive by the foreman in his prompt distribution of the work needed to fill orders against his shop, will minimize the difficulty experienced by some foremen in obtaining a fair output

per man. In connection with this qualification, the foreman should set a fair price for the making of each item. The list of prices should be placed in the shop where the men can refer to it, and the prices should be established according to the facilities at hand for doing the work. Under the day-work system a schedule of prices is necessary, that we may be able to operate intelligently. We are daily called upon to give the cost of producing this or that item, and to make estimates on work in contemplation. It is a specific for the disease of the chronic "time killer," and greatly relieves the over-anxious one of worry by knowing he has done all or more than was expected of him. In a manner, it makes each man his own foreman, and also relieves the one who has full charge and is held responsible for the output of the shop of the unpleasant duty of urging them to a fair day's work.

The writer established the schedule rule some years ago the shop he has charge of, and it has proved perfectly satisfactory to the men, giving them, as it does, steady employment, and to the company by an increased output up to the full limit of good workmanship. But we should not forget that we are living in an advanced age, an age of quick production and keen competition, the stimulus of which has revolutionized the crude and slow method of production by hand in the smith shop of a few years ago to the rapid output of to-day by machines and their complement of proper tools.

We will follow this change of method of production by illustrating with only a few of the minor articles in constant demand. Yet a like change giving an increased output has taken place in a greater percentage of the full output of the shop. A few years ago drawhead pockets were made under the steam hammer at about one-quarter of a cent per pound. To-day they are made by the geared or pneumatic bulldozer at about one-eighth of a cent per pound. They were applied to the drawheads by hand at a cost of about 10 cents each. To-day they are applied by the small pneumatic bulldozer for about 2 cents each. Grab irons were made by hand on the anvil for 10 cents each. The steam hammer with the proper tools cut this price in two. The geared machine in its turn reduced the price set by the steam hammer, and to-day they are made on both the quick-action header or the pneumatic machine with specially designed tools for about 1 cent each, *day work*. Arch bars formerly bent by 3 or 4 helpers sledging them to the shape of a former, are now made on the 100-ton bulldozer or pneumatic machine for about 3 cents per 100 lbs. The cost of this class of machine work depends largely on the capacity of furnaces.

Many heavy parts of coaches, such as transoms and equalizers, are now bent on the bulldozer more accurately, at less cost, and with less abuse to the material than they formerly were under the steam hammers. This change of method for the better follows on through many of the heavy parts for engines. Main and side rod straps were pretty generally, and are yet by some, forged and bent in a solid or rigid tool under the hammer, thus upsetting, disarranging and frequently breaking or checking the fibre on the under side of the bend (in the corner), which is the vital part of the strap, as they never break on the outside corner first. They are now forged under a hammer of the proper weight and bent with rollers on the bulldozer. The forging is left full where the bends are to be made, and with the rollers properly adjusted the outside of the metal at the bend is elongated sufficiently in the rolling process to accommodate the inside to a natural easy bend. Placed on a mandril and given a few blows under the hammer, it is without strain or distortion of any kind.

To emphasize the great advantage realized in the reduction of cost of output with proper tools, against hand work, I will make two more comparisons in minor articles. Some years ago drag chain hooks were made by hand of 1¾-in. stock at a labor cost of about 25 cents each. To-day they are forged of 2-in. square soft steel and bent on the small pneumatic machine at a total labor cost of 5 cents each.

Chipping hammers, such as used by machinists, boiler-makers and car-repair men, were made by hand at a cost of 30 cents each. They are now forged in tools under the steam hammer for 12 to 15 cents each.

I will at this point give a list of only a few of the many items that can be made with small power. One 12-in. cylinder, or 2 9-in. cylinders placed tandem on a small face plate for bulldozing purposes, will, with 100 lbs. of steam or compressed air, have sufficient power to bend the following articles: Drag chain hooks forged of 2-in. square soft steel; drawhead carriers, brake hangers, unlocking bars, lever guides, stake pockets, train pipe clamps, step irons, corner bands, end gate irons and grab irons as fast as they can be handled. By using 1 16-in. cylinder as described above, drawhead pockets can be applied for 2 cents each. Such cylinders can be found in most railroad shop scrap boxes, and if the foreman is denied something better they should be utilized as labor-saving devices.

The best workmanship and greatest output is obtained in the general run of the work by classifying it and giving each man all or as much of his particular class of work as he can do. In this way men become expert. Their work will be less laborious to them, the output will be increased and the quality will be of the best. If the foreman is a practical blacksmith, thoughtful and persistent in applying himself to duties as he understands them, there should be but little if any cause for complaint from his superiors.

The advantages derived from railway club and association meetings, which make not only common property of the over-estimated private shop kinks, secrets and formulas of the past, but offer to those who can appreciate the best and latest ideas and methods of to-day, and added to this the knowledge gained by being a reader of the railway mechanical publications, which give in almost every issue cuts of the latest machines and tools with their capacity, should help him to not only satisfy others, but, better still, to satisfy himself.

BOSTON & ALBANY RAILROAD PROGRESSIVE ASSOCIATION.

To the Editor:

It may be of interest to you to know that for some time past on the Boston & Albany Railroad, there was under consideration the advisability of starting an organization, practically a school for instruction on the locomotive, signals, train rules, etc., similar to that outlined in the editorial entitled "Education for Shop Men and Engineers" in your November issue.

This finally resulted, through the efforts of Traveling Engineer E. H. Smith, in the organization of the Boston & Albany Railroad Progressive Association, on November 22, with 18 charter members and more added each meeting since. The association is limited to employees of the motive power department, and will not admit officials. Two meetings a month are held and instruction is given by illustrated lectures, using a stereopticon, models, drawings, etc.

When the association was brought to the attention of the railroad officials they willingly fitted up a room at Allston with a seating capacity of about 60, gave the members permission to use books and drawings, and in every way offered encouragement and help. Firms manufacturing railway appliances were asked to aid and they promptly furnished drawings and in several cases full size models. All the argument needed, as one firm put it, was "the more your men know about our device the better satisfaction they will get from it."

The course of lectures planned for this winter will cover the locomotive; the first lecture is boiler construction, design and care. By using illustrations, models, etc., intelligently explained and freely discussed, the progressive examinations will lose much of their dread.

The Boston & Albany Railroad Progressive Association has had a fair start, with the good wishes of all, and we feel confident, that after the meetings this winter the members will find that the modern locomotive is much less a mystery than heretofore.

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ECONOMICAL TRAIN OPERATION.

By G. R. Henderson.

PART IV.

DEDUCTIONS AND CONCLUSIONS.

In making a study of train operation (such as we have just done) it is important that the different features be brought out clearly, so that their full value will be understood. The results are what is wanted in railroad operation, more than departmental benefits. The president of one of the most important lines in the Northwest once stated the matter clearly when he said: "If one deparment can so spend a dollar that another department can save a dollar and one cent, the expenditure must be made, regardless of the fact that the spending department was increasing its expenses." This is too often overlooked in departmental jealousies, and we frequently hear remarks such as "My department will not get the benefit of such an expense or improvement, and I am not going to increase my rolls." Then again, it is not an uncommon practice, when an excess of power has to be moved in a certain direction, for a division superintendent to send out one engine light, and one a few minutes after with a load that it can barely draw up the hills, simply to increase the average tonnage showing per single engine train mileage or per train mile, a light engine not being considered a train. If we use more fuel per 100 ton miles, but the saving in wages of crews more than offsets the value of this excess, the company is ahead, even if the general manager asks the motive power department disagreeable questions—questions which may be hard to answer unless the head of the department is well fortified both with theoretical knowledge and the practical results obtained. Unfortunately, while the motive power department may fix the rating of the engines, the general or division superintendent fixes the running schedule, and this is done independently of the former, and often without any knowledge of the effects of speed upon the coal consumption or the total cost of transportation. This is unfortunate for the railroads, but it is the usual method in this country.

In analyzing Table A it is noticed at once that the supplies (excepting coal) and the roundhouse charges are independent of changes in speed or the rating of the engine. In order to make these items a minimum per ton mile covered, we should use as heavy a train as possible; but these items are small when compared with the others, so that they really but slightly affect the general result. The repairs being based on ton miles, will not affect the cost per ton mile by changes in the speed or loading, under our hypothesis. The interest charges are small, so that even if it be claimed that the engines are in the house and interest must be paid whether used or not, the result will be but slightly affected. This leaves us only the fuel and wages, which are large items in point of cost, and which depend upon the speed and load.

Fig. 3 is introduced to show graphically the results caused by varying the load, and consequently, the speed. The lower diagram is arranged to show the effect of changing the load back of the tender. Examining the line marked "average speed, No. 6" (the numbers referring to the line in the table corresponding to the same item), we find that a decrease in load of 30 tons (say one car), or from 1,450 to 1,420 tons, permits doubling the speed, while to treble it, 260 tons must be dropped, and to quintuple it, more than half of the full load must be left over for another train. The greatest benefit of a decreased load is therefore found at slow speeds, where a reduction of 2 per cent. enables the engine to run at double speed. We observe from line No. 21 that the coal consumption per ton mile has risen 17 per cent., and if this were a general thing for the month, the superintendent of motive power would have to answer questions, which, it is possible, he could not do unless well acquainted with the train movement for the month. But let us see what has been gained. The total cost of movement per 1,000 ton miles moved has been reduced 5 per cent., and the same engine or engines have increased the ton mileage over the division 75 per cent. Here is where the division superintendent gets the credit for the large amount of traffic handled, and the motive power department gets a "raking" for the increase in coal consumption.

"These things ought not so to be." But if a little reduction in the load is good, will not more be better? And where should we stop? Unless we are considering a stock movement or a lot of perishable freight, we can find the answer in Fig. 3 and Table A. It happens in this case that a load of 1,190 or say, 1,200 tons nett, gives us not only the lowest cost per 1,000 ton miles, but also the maximum monthly movement. The engine is able to run at 15 miles an hour, or with 20 per cent. in stops, etc., to average 12½ miles an hour; this brings about a reduction of 16 per cent. in the operating charges scheduled, and an increase of 98 per cent. of stuff hauled; in fact, while the train load has been reduced 18 per cent., the engine has made the trip in one-third of the time,

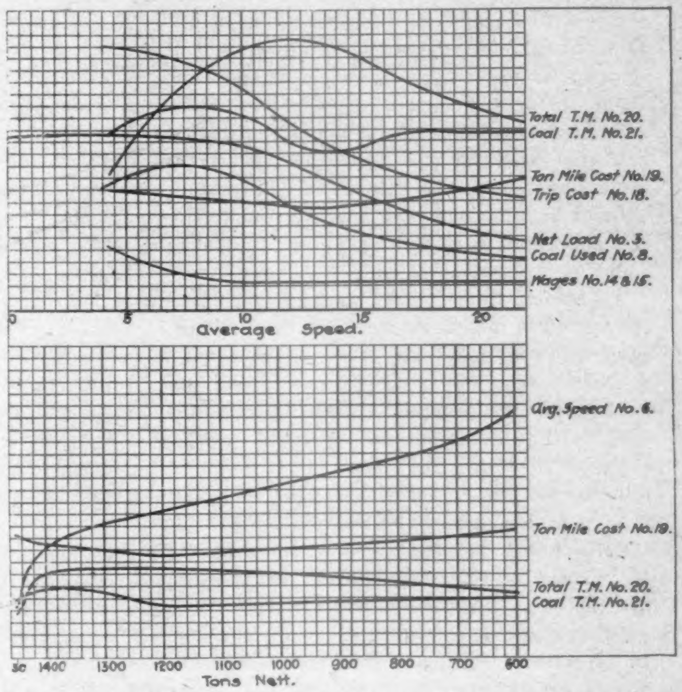

FIG. 3.—EFFECT OF VARYING THE LOAD AND SPEED.

and has done the work of two locomotives! If we compare the two methods of operating, we see that a division worked in accordance with the first schedule would show better records for large train loads, and if the general manager had a hobby for heavy trains, the superintendent would get more praise than in the third case, where he got twice as much work done per engine at 5-6 the cost of movement.

From the replies to the inquiries mentioned in Part I. it was clear that the benefit of reducing loads in times of traffic congestion was generally conceded, but the above discussion suggests that it would be good practice at all times, on such a division and under the conditions which we have assumed. It demonstrates that heavy trains do not always mean economy—not even in coal consumption, as it is seen that the rate per 100 ton miles is less at 15 than at 5 or 10 miles an hour.

As we still further reduce our load, and operate at higher speeds, we lose both in economy and in total work done; the rate of fuel consumption also increases. These circumstances are brought about by the fact that it takes more coal per ton mile to move a train fast than slow, and that after we average 10 miles an hour there is no reduction, caused by the speed, in the wages of the crews, they being paid by the mile, as already explained.

The upper diagram of Fig. 3 illustrates the variations due

to speed. Here it will be seen that the line of wages is horizontal above 10 miles an hour. From lines 18 and 19 it will be evident that while the cost per trip decreases with each increase of speed, the cost per ton mile decreases to 12½ miles an hour average speed, and then increases for further increase in velocity. The same is approximately true of the coal consumed per trip and per ton mile. Under the conditions assumed, therefore, it appears that economical operation, both from a standpoint of large movement and low unit cost, demands loading the engines so that they can make 15 miles an hour while running. Of course, it is supposed that there are sufficient sidings, etc., to allow a prompt train movement in both directions.

Case A, which has just been considered, may be claimed to be a purely hypothetical one, and not occurring in ordinary practice. We admit that divisions 150 miles long, with a continual rise of 1 per cent., are not common, and yet the writer knows of even worse cases. But B and C are very ordinary cases, the one having a summit at the middle of the run, and the other constituting a rolling profile. Under these suppositions, it will not be necessary to consider the direction of prevailing traffic, as the operations in either direction will be identical. In comparing tables A and B we are at once struck with the difference in cost of operation, the latter being about 2-3 of the former. Inspection shows us that this is due chiefly to the quantity of coal burned, which is only one-half that used for the continual rise of case A. Under the same hypothesis, the return run of case A would be made without burning any coal, and the round trip would in a measure approximate to case B, except that a very large tonnage could be brought down hill, if it were there to be handled.

As before, items 10, 11 and 16 are unchanged throughout the variation in schedules, and with numbers 12 and 13 are the same as in case A. The down grade speed being maintained at 25 miles an hour, the average speed over the division is greater for the different speeds up hill than in the previous case until it reaches that due to 25 miles an hour on both sides of the hill. The wages (14 and 15) being identical per trip for all but the first schedule, increase the cost per ton mile at higher speeds and reduced loads.

Considering the questions of cost of operation and work accomplished, we are struck in our examination of table B with the fact that the cost of handling per ton mile is the same, whether a speed of 5 or 10 miles an hour up hill be permitted. It happens in this case that the increased fuel consumption due to greater speed is fully offset by the reduction in overtime, due to such speed, as the trip only occupies 12.6 hours between terminals instead of 21.6 hours. The amount of traffic handled per engine each month has, however, been increased 48 per cent. Under these two operating conditions, the expense is just the same, and the first method will enable the superintendent to show heavier train loads, where this is considered most creditable, but the second arrangement permits a great increase in traffic handled, besides keeping the men in much better humor on account of a quick run over the division, which is not without a good effect upon the morale of the service. However, if we go still further and cut our train load 18 per cent. so that 15 miles an hour may be made up grade, a reduction in the cost of operation of 6 per cent. is effected, with 50 per cent. increase in work done per engine, or two locomotives run on this schedule would do the same amount of work in cleaning up a congested freight yard as three on the first schedule. It also happens in this case that the coal consumption per 100 ton miles is less, due to expansive working of the steam in the cylinders.

If the load and running time be still further reduced, the economy and amount of business handled will suffer—thus at 25 miles an hour the cost per 1,000 ton miles will be 32 per cent. greater and the tonnage handled per month 40 per cent. less than at 15 miles per hour running time. This shows us why stock trains are so much more expensive to handle than ordinary freight, the increased cost being as above for similar existing conditions. If the speed be still further increased, the excess in cost will be yet greater, and the amount of tonnage smaller. These figures give a logical argument for higher charges for such freight, in addition to terminal expenses for handling and caring for the stock while in transit. Of course, everyone knows that freight rates are not determined by the cost of transportation, and yet it is desirable to know the relative cost of different kinds of service. As before, 15 miles an hour running time gives the greatest benefit, both as to economy and amount of business handled.

In case B, just considered, the average profile was level, that is, there was as much down hill as up hill, and the schedules were determined by fixing the working speed up grade. In case C, while the profile is still level, as far as the average is concerned, the up grades are so short that it would never be considered good policy to load an engine so that it could make fast runs up these hills, but the level stretches must be depended upon to make up time on a fast schedule. For this reason but two ratings are used in our discussion, 1,870 tons and 1,820 tons, or 3 per cent. less. From Fig. 2 this was seen to make a difference of from 5 miles to 10 miles an hour on the 26 ft. per mile up grade, but as the up grade only comprises 30 miles of the 150, this really increased the average speed but 23 per cent. for the whole run. Again, however, there was an advantage in operating, as the total monthly ton mileage was increased 15 per cent. without any increase in the cost of operation, both standing at 45 cents per 1,000 ton miles. The coal consumption, however, is 13 per cent. greater, so that the only gain is in the increased hauling capacity of this schedule. If we consider trip 3 we find that the time between terminals is the same as trip 2, viz., 15.8 hours. In this case, however, the time is 5 miles an hour up hill and 15 miles per hour on the level. With this arrangement the full tonnage can be taken, resulting in an increase of about 3 per cent., and the cost is about 2 per cent. lower. In this case we find the greatest economy is to use the full rating and to run at 15 miles an hour on the level. While there is very little difference in the ton mile cost of the various schedules of case C, yet this method gives the lowest cost of operation both per train mile and ton mile of the series.

Now let us examine a still further increase of speed on the level, say to 25 miles an hour, but maintaining our full load and slow speed up hill. Here we find (trip 4) that the cost of operation has suffered a rise of 5 per cent., but the rate of output has improved about 16 per cent. This output can be still further increased by reducing the train load so that 10 miles an hour can be made up hill, the level speed being continued at 25 miles an hour, as exhibited in trip 5. Here the monthly rate is 41 per cent. better and the cost per ton mile only 8 per cent. more than trip 3, which was the lowest in cost. This table (C) therefore, indicates that for ordinary working conditions, the method shown by trip 3 is the most desirable, as it is the lowest in cost, but if traffic should become congested, great relief (that is 41 per cent.) can be effected by using schedule 5, thereby increasing the cost 8 per cent.

Although tables B and C cover operations over divisions that are an average level, we find great differences in the cost and best methods of operation. The most economical operation of case B (1 per cent. grades) cannot be expected to approach within 40 per cent. of the economical working of case C (½ per cent. grades and level stretches). This is due entirely to the profile of the road, and explains the uselessness of attempting to make comparisons of the cost of operation of different divisions, which have unlike profiles. Even the same profile with a different kind of traffic will be subject to great variations in cost. For instance, if one month there were few fast freights, and the same month in the following year there was a large proportion of this business, the expense of operation would be sure to go up unless there were other offsetting conditions. In this way praise or censure is often given when no one is responsible for the changed conditions, unless it be the traffic department for obtaining a different grade of merchandise for shipment. It is absolutely impossible to make comparisons in such cases unless all the conditions bearing

on the case are known or considered, yet it is often done in just such an unmethodical manner. Comparative statements, apparently voluminous and complete, often omit the essential points for forming sound judgment.

In one point the 3 cases considered practically agree, that at an average speed of from 12 to 15 miles an hour the greatest economy is found, but the possibility of moving a large quantity of freight depends upon the detail conditions of the line. Whether a heavy or moderate loading for the engine is best depends also upon the profile and existing conditions. It must not be thought that the 3 sections of road here considered are intended to cover all cases—indeed, each division should constitute a study by itself in some such manner as we have indicated, and the necessity for liberal co-operation between the various departments will certainly be understood by the foregoing suggestions. In each case the proper values should, of course, be assigned to the different items constituting the charges, as these will be different for various localities.

As we explained in Part I., the whole cost of operation will be about 3 times that shown by our figures, which include only the items directly connected with the train movement, and without knowing the amounts of these other charges the total cannot of course be figured, but for determining the minimum cost and maximum capacity, it is not necessary to know the items not directly concerned. The total cost of operation will evidently not be a function of the cost shown, but an addition to it, which is less per ton mile as the quantity of commodities handled increases.

The revenue ton mile is also much less than the gross ton mileage (car and loading) which we have considered above. In a fully loaded car the revenue load may be 2-3 of the gross load, but the ordinary run of loads as they come in merchandise trains will not average over 50 per cent. of the total weight for the weight of revenue freight. It is quite plain from the discussion that roads with heavy grades are unable to operate at the same cost as those with low grades, and that where we find a low operating cost for a large system it means that the great proportion of easy profiles modifies the high cost of mountainous territory, reducing the average. Where two railways connect at the same points, but one runs over a succession of mountain ranges, it is a hopeless task to expect to reduce the expenses to that of a road which has a valley route, unless it be badly managed. However, much can be done by adopting *an economical train load*, whether it be the greatest that the engine can haul or a moderately heavy load permitting a good running schedule, this to be determined for each particular case on the principles laid down above.

AUTOMATIC STOKERS FOR LOCOMOTIVES.—The necessity for an automatic stoker for the large locomotive, either passenger or freight, is quite generally recognized, and the requirements have been met in a very satisfactory manner by at least one form of stoker. It is strange, therefore, that a stoker which has been upon the market for several years, and which works so successfully, does not become regularly adopted by the railroads, which seem to need some such appliance to assist the fireman in his arduous work. The testimony as to the success of this device is the most convincing of any relating to locomotive improvements (containing such radical changes in methods of operation) which have been introduced in many years. The reports of the laboratory tests at Purdue show it to have given a very satisfactory performance. The testimony of motive power men who have had quite a number of stokers in use is entirely favorable to the device, and the opinion of the superintendent of our largest locomotive works is that the stoker is the coming device.—*Wm. Forsyth, before International Engineering Congress.*

The American Locomotive Company has presented to Purdue University, Lafayette, Indiana, the full-sized model locomotive cylinders sectioned to show the piston valve construction which formed a part of its exhibit at the Louisiana Purchase Exposition.

THE COLE 4-CYLINDER BALANCED COMPOUND.

An important, but misleading, criticism of the Cole 4-cylinder balanced compound locomotive appeared in a recent number of the *Railroad Gazette*, over the signature of Mr. L. E. Moore, instructor in mechanics, of the University of Illinois. This criticism cannot have been based upon mature deliberation, and to guard against the possibility of creating a widespread impression to the effect that this locomotive is not vertically balanced, a statement of the facts seems to be required. Mr. Moore's criticism is as follows:

"As regards forces in a horizontal plane through both axles, the locomotive is balanced; but consider for a moment the vertical forces upon the back pair of drivers alone, when rolling on the track. The conditions here are exactly the same as in an ordinary locomotive; for the vertical forces exerted by the reciprocating parts connected to the front drivers cannot interpose between the back drivers and the rail to balance the vertical forces exerted upon the back drivers by the reciprocating parts connected therewith. It must follow, then, that the reciprocating parts connected to the back drivers, being unbalanced, and quartering or at 90 deg. with each other, must produce a very severe hammer-blow upon the rails at every revolution. The same reasoning, of course, holds with the front drivers. If all these cranks were on one axle, or if the two cranks on each axle could be opposite, and similar parts had the same weight, the engine would, of necessity, be exactly balanced. But the splitting up of the cranks, as done in this engine, between the front and rear drivers, must necessarily result in unbalancing the vertical forces upon each axle. These forces are the ones of importance, so far as destructive action upon the rails is concerned."

The arrangement of this locomotive was illustrated on page 240 of the June number of this journal of last year. Mr. Moore has fallen into the error of regarding the reciprocating parts as producing a "hammer-blow" upon the rails at every revolution. In a balanced engine one set of reciprocating parts on the inside of the frames balances those on the outside, which move in an opposite direction, so that the use of the customary counterweights for the reciprocating parts in the wheels are rendered unnecessary, and engines of this description run very smoothly without their use. This is clear to anyone who reads what is said of the smooth operation of the many de Glehn compounds in Europe.

The action of the reciprocating parts is entirely horizontal, and no vertical force can be exerted by these parts, excepting the slight vertical component produced by the main rod, hence no pressure can be produced upon the rail by the action of the reciprocating parts. Mr. Moore confuses this with the "hammer-blow" in ordinary engines, which is produced by the overbalance in the wheels of ordinary engines to take care of the reciprocating weights, but even in these engines the reciprocating parts themselves have nothing directly to do with the "hammer-blow." With a 4-cylinder engine of this construction it does not matter whether the cylinders are all connected to one axle or not, as far as the balancing is concerned. In either case the reciprocating weights counteract each other, and the balancing of the rotating parts is all that is necessary; as a matter of fact, a very large proportion of 4-cylinder compounds of this general type are divided, as are the DeGlehn compound, the Cole compound and the Burlington compound, all of which have been illustrated in this journal. The Cole locomotive referred to has been run continuously for an hour on the Pennsylvania testing plant at St. Louis at a speed of 75 miles per hour, which alone effectually refutes Mr. Moore's criticism in the smoothness of the running, and in the demonstration by means of wires run under the wheels, these wires having been flattened uniformly throughout their entire length. Mr. Moore's criticism would be important if true, but those who are interested in the 4-cylinder balanced compound are very glad that his criticisms are erroneous.

MILLING MACHINES IN RAILROAD SHOPS.

The comment on the extensive use of milling machines in English railroad shops, which appeared on page 344 of our September issue, suggests the question as to why the same does not hold true in American shops. With the rapid progress that has been made during the past few years in the way of new shops and new equipments of modern tools fitted with the best cutting steels that are to be had, regardless of first cost so long as there is a possibility of greatly increasing production by rapid machining processes, it is surprising that more milling machines are not installed. A few American shops are now using millers on side rods, among them the Altoona shops of the Pennsylvania Railroad, where good results are being obtained, and this, together with the experience of English shops on similar work, is in itself proof of the economy of milling these over planing.

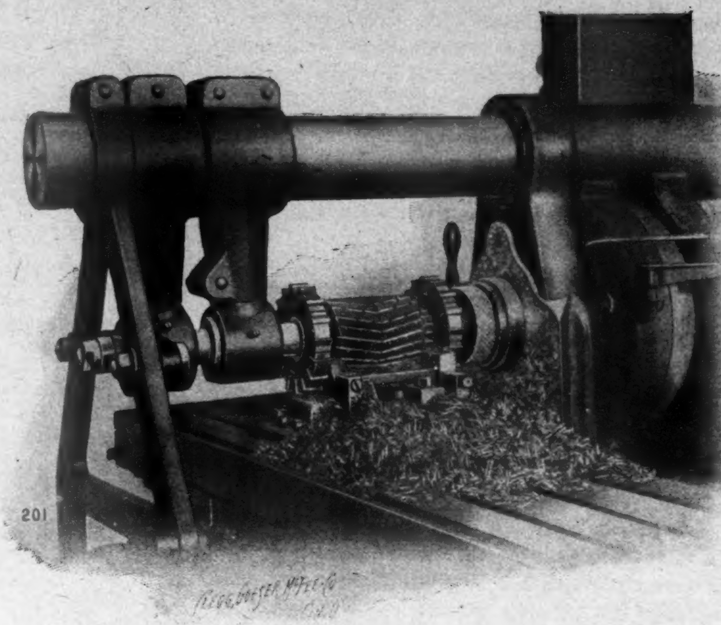

FIG. 1—METHOD SUGGESTED FOR MILLING DRIVING BOX SHOES.

In a great many American shops we have noticed milling machines used for sinking the end of flutes into the rods and the middle part was afterward planed out, the reason given being that while the planer could not finish the end of the groove in the rod, it could remove the metal from the middle section more rapidly than the milling machine. The reason for this must be that the planers used are better equipped for the work than the millers that happened to be in the shop. When such work is finished complete on a heavy miller, there should be a marked saving in time of the actual cutting operation, and in addition to this the time required for handling the piece from the miller to the planer would also be saved, so that altogether there should be at least a 25 per cent. saving by milling. For such work a heavy planer type miller is best adapted, and a machine should be selected large enough to mill several rods, placed side by side, at one time. The cutter arbor should be very large in diameter and well supported, and the cutters as small in diameter as it is possible to make them, and still have sufficient strength in the body to stand a heavy cut without splitting open. Since these cutters must necessarily have large round corners, and must be adjustable, so that their size may be maintained after repeated grindings, it is perhaps best to make them with inserted teeth, and these teeth should be alternately nicked to break up the chips. The body of the cutter should be made of machinery steel. Twenty feet per minute is a good basis for peripheral velocity of the cutters, and the feed should be limited only by the pulling power of the machine. In general, it may be said that fast feeds not only have the advantage of rapid production, but also materially reduce the tendency of the machine to chatter.

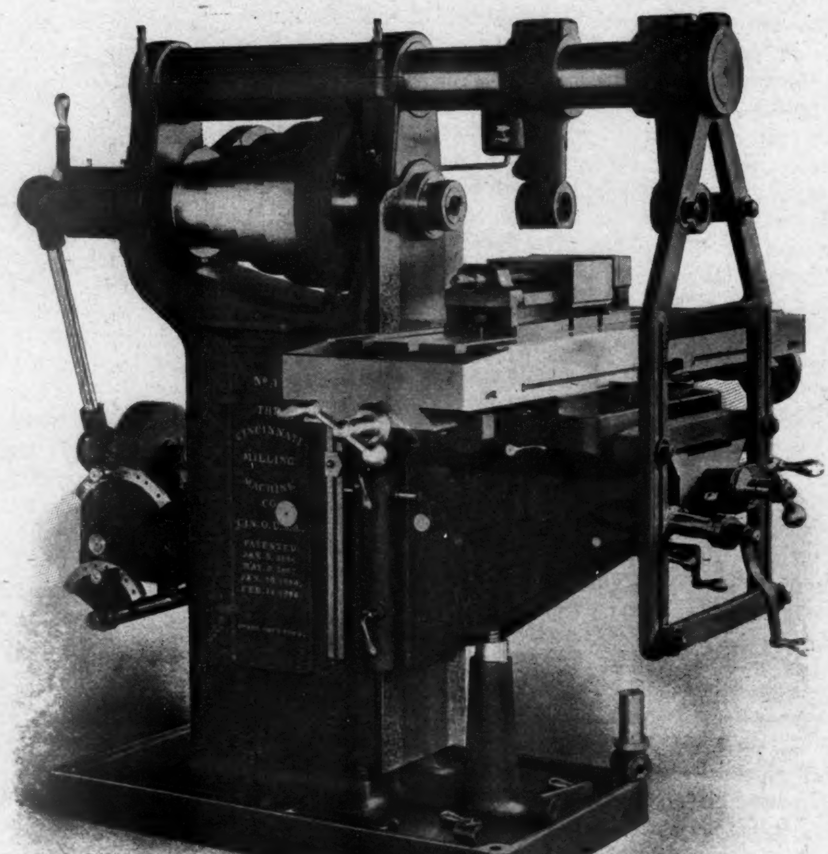

FIG. 3—NO. 4 PLAIN CINCINNATI MILLING MACHINE.

In addition to side rods, there are a large number of smaller parts which can be milled to good advantage—for instance, driving-box shoes can be handled very nicely on the ordinary column and knee-type miller by using a gang of cutters and chucking the work, as shown in Fig. 1. This illustrates a No. 4 Plain Cincinnati Miller on work of a very similar nature. The casting is 8 ins. wide over all. The total width of the finished surface is 13 ins., and the largest cutters are 6 ins.

in diameter. The depth of the cut runs from ⅛ to 3-16 in., the speed of the cutter is 33 r.p.m., and the table feed is 5½ ins. per minute without the slightest sign of chatter. This is indicative of the possibilities of these machines. It will be noted that the main body of the cutter is solid, has spiral teeth, and that these cutters are of the ordinary inserted tooth variety. Rod brasses and similar parts can be milled in the same manner at about twice the above rate.

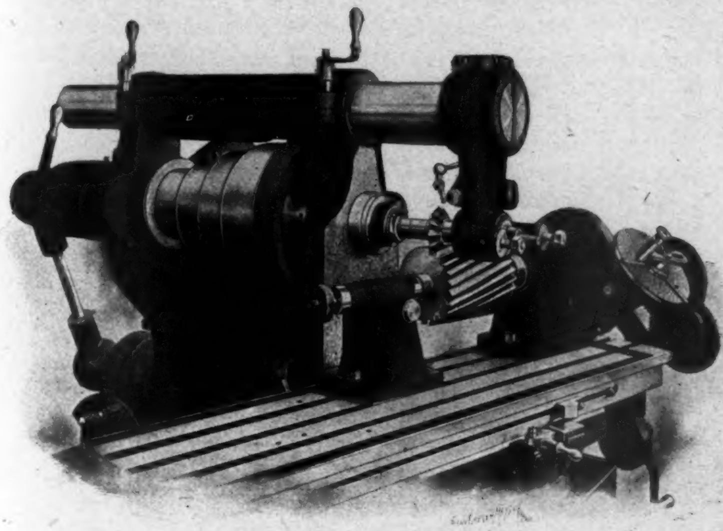

FIG. 2—MILLING A HEAVY SPIRAL CUTTER.

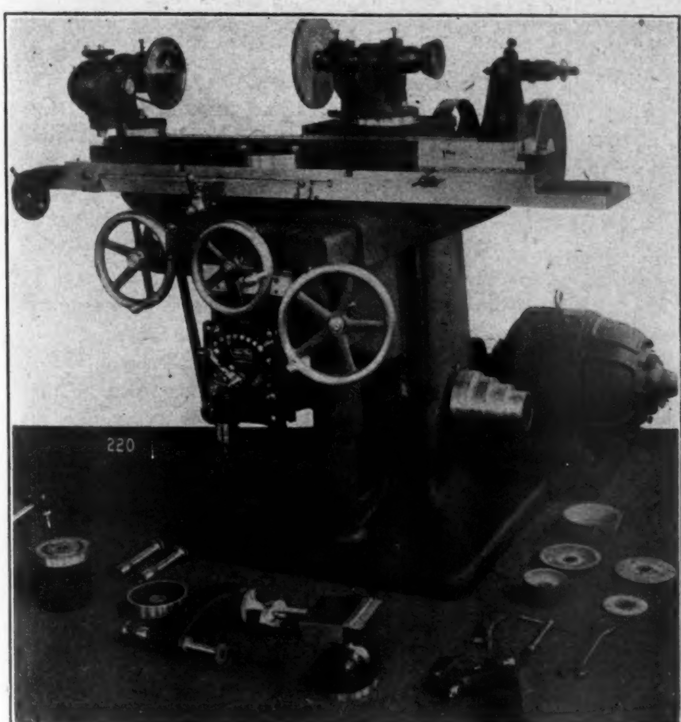

FIG. 4—NO. 2 CINCINNATI UNIVERSAL CUTTER AND TOOL GRINDER.

The time required for chucking the work on a miller is in no case more than that required for chucking it on a planer or shaper and working within the above practical limits of feeds, the gain is about 50 per cent. after due allowance has been made for maintenance of cutters. Of course, if milling is carried on to any great extent, it is necessary to provide the means for making and maintaining cutters, in other words, there must be an efficient tool room of ample size in connection with the machine shop, and here again practically all of the work can be done on milling machines with the single exception of the grinding operations. Fig. 2 is an interesting illustration of doing work in the tool room. This shows a No. 3 Universal Cincinnati Miller fitted with a head especially adapted to heavy spiral cutting. The blank is a piece of unannealed steel 5⅛ ins. in diameter, the flutes, being milled, are approximately ½ in. deep by ¾ in. wide at the top, and all the stock is removed by a single cut at a feed of over 1 in. per minute.

For ordinary slab-milling it is always desirable to use arbors of large diameter, and keep the diameter of the cutter as small as possible; therefore solid cutters will invariably give the best results, since the inserted tooth style must be comparatively large in diameter. Slabbing cutters should have the flutes spaced far apart, to give ample room for the chips, and they should not be milled too deep, so that they will have sufficient strength left for taking heavy cuts. The teeth should be alternately nicked so as to break up the chips, as

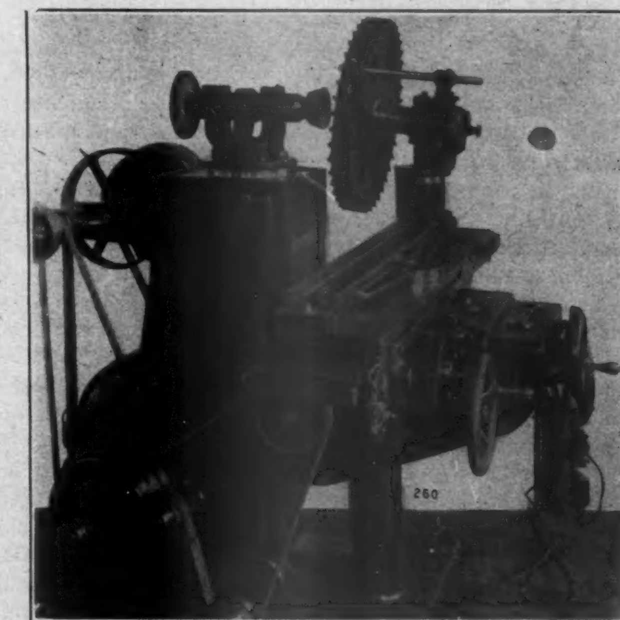

FIG. 5—SHARPENING THE SIDE TEETH OF A LARGE INSERTED TOOTH FACE MILL.

FIG. 6—SHARPENING A SPIRAL CUTTER.

this permits of faster cutting and greatly reduces the tendency to chatter.

An indispensable adjunct to the tool room miller is a convenient, simple and efficient grinder for keeping the cutters properly sharpened. The machine shown in Fig. 4 is adapted for grinding a variety of milling cutters that cover the complete range of cutters in practical use. Fig. 5 shows it in operation sharpening the side teeth of a large inserted tooth face mill. The teeth on the other side and also the peripheral teeth are sharpened in the same manner and with the same fixture without removing the cutter from the shank. It is

held directly in the spindle of the head center of the grinder, so that while being ground, it revolves in a true plane about its axis and will therefore run true on its own arbor. This also applies to mills of smaller diameter, such as the ordinary end or butt mills, and these are held on their own shanks while being ground. The ordinary slabbing cutter is ground between centers, as shown in Fig. 6.

It will be noticed that in all of the above grinding operations a cup-shaped wheel is used. This is the proper method, as it gives a straight line clearance to the cutting edge instead of the cupped-out clearance that is obtained when the periphery of a disk wheel is used. In general, milling cutters will give the best satisfaction and their edges will last the longest if they are sharpened with an angle of about 5 degrees. In the case of end teeth of butt mills, or side teeth of large inserted tooth mills, this angle is obtained by setting the spindle of the index head to the desired angle, which may be read direct from a dial provided.

WATER SOFTENING.

Control and Results from a Chemical Standpoint.

BY G. M. CAMPBELL, P. & L. E. R. R.

The problem of softening water is not a problem of pure chemistry. Results on water passing through a softener at the rate of 60,000 gals. an hour, cannot be the same as those on a small laboratory sample where several days may be taken to make the reactions complete. Again, the materials used in water softening are not chemically pure, the labor is unskilled instead of highly trained, and the machine is subject to many limitations. When it is considered that even in a hard water the amount of material is extremely small—1 lb. of scale forming matter in 200 gals. of water would be an extremely hard water—and that the treatment is taken care of by unskilled workers who know absolutely nothing about the theory of chemistry, the results obtained with many softeners are indeed remarkable.

The title of this paper presupposes that water softening apparatus is in use; the softening of water by adding chemicals to the boiler or locomotive tender is entirely inadequate and inefficient. All water softening machines are not of the same value, some undoubtedly perform their work better than others, and it is poor economy to put in an inferior machine simply because the initial cost is somewhat lower. An inferior "continuous" softener, if used on a water of constant quality and of a uniform rate of flow, might work entirely satisfactorily because the necessary adjustments could be made to suit that one condition. But when the water varies widely in quality and supply, the mechanical mechanism of the machine must be as nearly theoretically and practically correct as possible, otherwise a badly fluctuating softened water will be the result. With a properly equipped and properly controlled continuous softener, results can easily be obtained in every respect equal to results with an intermittent machine, and at a very much less cost for labor and power, especially in the larger units, no matter what the quality or variation of the water.

After the machine has been chosen and installed it should be maintained in as good a condition as is possible; all adjustable devices should be carefully and regularly inspected. With the machine working at its maximum efficiency, everything depends on the proper proportioning of the treating chemicals to the quality of the water to be treated. With a water of unvarying quality, samples can be sent at intervals to a chemist and the resulting treatment based on his analysis. Many deep-well waters are fairly constant as far as scale-forming constituents are concerned, but even these waters vary in the amount of free carbonic acid present, which would require a change in the lime treatment. But with waters from rivers or shallow ponds or even shallow wells, the changes are far too rapid and uncertain to allow of successful treatment based on occasional full chemical analysis. Tests of the water at the time of treatment are absolutely essential; it is impossible to satisfactorily treat such waters otherwise. It is, of course, out of the question to maintain a chemist at each water softening plant to make the necessary analyses, consequently the tests must be so simple that the ordinary unskilled workman can understand them—not understand the reasons back of the tests, but be able to note certain results of the test and to intelligently base thereon his subsequent treatment. Owing to the inability of the ordinary workman to understand completely the chemical tests and the chemical reactions in the softener, he is incapable of drawing any correct conclusions as to what changes in treatment are required, if the treated water is not as it should be; consequently the treatment, in so far as quantities of chemicals required is concerned, should be beyond his control and he should not be held responsible for the quality of the treated water. He should be given definite written instructions, put in simple language, to make certain simple tests at stated times and to put in certain charges in accordance with his tests. He should also be held responsible for the mechanical working of the machine; but there his responsibility should end. This limiting of responsibility has one very good result—it removes from the attendant all desire to falsify records. The results of the treatment are, therefore, correctly given, and if these results are not sufficient, the necessary changes can be made in the charging tables or in method of testing and treatment.

With a number of water softeners all supplying water for one common purpose, such as may be found on a railroad, it is necessary that the water should be nearly uniform, and therefore it is necessary that the man ultimately in control should be kept fully informed as to what is happening at the various plants. The first step is to have regular reports sent him from each plant of the quality of the raw water, the quality of the treated water, the quantity of chemicals used, the amount of water pumped, etc. The work at any properly equipped pumping plant is such that the attendant can easily find time to make such report, provided easily understood blank report sheets are furnished him. The attendant may be painstaking and honest, but if he finds that his results go unchecked he will sooner or later become careless or inaccurate. Adequate check must therefore be provided, not in the nature of spying, but in the nature of records and samples, so that the attendant can easily see that he must sooner or later be detected in any inaccuracy or carelessness. The usual check on the attendants is to have an inspector make more or less regular visits to the plants to note conditions. Owing to the long distance between plants, especially on a railroad, the interval between visits would be long, and, moreover, there is no guarantee that the records and treatment are correct in the interim. A very satisfactory check is to have samples regularly collected and forwarded to some central point where they are checked by the inspector, not to make a full analysis, but simply the same tests as were made at the plant. Samples collected three times a week would usually be found quite sufficient. It is altogether improbable that, if the results are correct on Monday, Wednesday and Friday, the results on the other days would be incorrect; this is especially true if the samples of treated water are drawn from a storage tank. The results of these tests should be carefully compared with the records made by the attendant. Small discrepancies are to be expected; any large discrepancies should be noted and attendant asked to explain. If the number of plants is sufficient to warrant the expense, there should be assigned one man to test all these samples and at intervals to visit all the softeners, but more to look after the mechanical equipment than the chemical treatment; the chemical treatment can be accurately controlled from the central office and results definitely determined, and any departure from proper treatment can be easily detected. This is especially the case with varying river waters, as, owing to the rapid fluctuations and the general relation the results at one softener must bear to the results at the soft-

ener a few miles down stream, it is impossible for the attendant to so falsify records or to collect his samples that the error cannot be detected. If records are accurate and reliable, it is not at all a difficult problem to obtain any desired result. It would thus seem that rapidly varying waters could be very easily controlled, though this is contrary to common report. It must be borne in mind that, as stated before, such results on variable waters are obtainable only when the machine responds quickly to any change in treatment and when the feeding of chemicals is strictly proportionate to the amount of water pumped.

These general statements are based largely on the result of the control of the softening plants on the Pittsburgh & Lake Erie Railroad. There are ten plants in all, all installed by the Kennicott Water Softener Company: one has a capacity of 60,000 gals. an hour, five of 42,000 gals., three of 21,000 gals. and one of 15,000 gals. Several articles in connection with their installation and operation have already appeared in this journal. The machines have lent themselves admirably to the very severe conditions which are met with on the road. Of the ten softeners, only that at McKees Rocks is using well water; one, at Whitsett Junction, is using water from a shallow pond; the other eight use water from six different rivers. One plant is on the Youghiogheny River, two on the Monongahela, two on the Ohio, one each on the Beaver, Shenango and Mahoning. No two of these waters are the same, even the two on the one river differ considerably. Success with the varying river waters has been so satisfactory that the well at McKees Rocks is shortly to be abandoned and river water used. An average saving in chemicals alone of about $10 a day will be effected thereby. At Buena Vista, on the Youghiogheny River, the raw water, during the present summer varied in hardness from 5 to 48 deg., and as much as 10 deg. in one day, and varied from an alkalinity of 4 deg. to an acidity of 30 deg., and as much as 10 deg. in one day. Whitsett raw water, from a shallow pond, has varied in hardness from 16 deg. to 33 deg.; McKees Rocks, well water, from 36 deg. to 44 deg.; the others from about 5 to 25 deg. All these waters are brought down to an average of about 6 deg. in hardness, and an equivalent alkalinity and causticity. The conditions have been apparently very adverse, the waters very hard, acid and variable; yet the results have been satisfactory beyond question.

The various solutions used in connection with the testing at the softeners are as follows: Standard soap solution, fiftieth normal sulphuric acid, fiftieth normal sodium hydrate, methyl-orange indicator called "red indicator," and phenolphthalein indicator called "clear indicator." Results of all tests are expressed in equivalent parts of calcium carbonate per 100,000; the quantity of water taken for each test is such as to give that reading in cubic centimeters (c.c.); each part per 100,000 is called 1 deg. The general meaning and value of the tests need not be given here; they will follow later.

Identical testing and charging instructions are in force at all softeners and also almost identical charging tables when brought to the basis of 1,000 gallons treated; the amount of chemicals used is but little above the theoretical amount required, and the results obtained are, all things considered, remarkably uniform. Credit for this satisfactory condition is due, first, to the softener, and, second, to the general method of control which keeps all plants under strict supervision, yet with a minimum cost for inspection; the installation of these plants necessitated the addition of but one man to the company's payroll, a chemist or inspector. A small chemical laboratory was opened. This is not an absolute necessity, testing solutions could be purchased and simple tests could be made with a duplicate equipment to that at any of the softeners, but the small initial outlay, $250 to $300, would soon be saved in the manufacture of testing solutions and in making tests, which would otherwise have to be made at a regular laboratory. The work in the laboratory consists in the making of all testing solutions, such solutions being standardized against solutions of known strength, the making of partial analyses of any special samples of water from any source whatever, and the testing of the samples regularly sent in from the softeners. While the work is quite simple, yet it is advisable to have a technical man in charge. On roads where a regular testing laboratory is maintained, this work could very easily be taken care of.

The instructions to the softener attendant and the report sheets given in this article have special reference to the particular type of machine in use on the Pittsburgh & Lake Erie Railroad and to the general conditions on that road. Alterations could easily be made to suit any other conditions. At each softener there is a chemical cabinet which is about 33 ins. high, 28 ins. wide, 12 ins. deep and holds the complete testing outfit. This outfit now consists of: 3 25-c.c. burettes; 3 burette stands; 4 2-liter bottles with syphon attachment, containing respectively standard soap solution, standard soda solution, standard acid solution, and distilled water; 1 4-oz. round bottle; 2 8-oz. round bottles; 1 8-oz. square bottle; 2 dropping bottles, one containing what is called "red indicator," the other "clear indicator"; 1 100-c.c. graduated cylinder.

(To be continued.)

AWARDS TO PENNSYLVANIA RAILROAD

The remarkable display made at the St. Louis Fair by this road received fitting recognition from the juries of awards in the form of a large number of prizes and medals. A special commemorative grand prize was awarded for the series of scientific investigations of locomotive performance, and other prizes for the terminal station models, for the locomotive testing plant, and the other features of the collective exhibit. A grand prize was awarded to the Societe Alsacienne de Construction Mechaniques for the deGlehn compound locomotive, and gold medals were awarded to the collaborators in connection with the general exhibits and the locomotive testing plant. The members of the various committees and officials in charge of the testing plant were included in this appropriate recognition of the plant and its valuable work.

ECONOMICAL TRAIN OPERATION.

Mr. Henderson closes his series of four articles on train operation in this number. This important contribution to the literature of railroad operation is a result of the letters from railroad officials, printed in this journal last June, and Mr. Henderson's work places in the hands of general managers information which will help them through the next period of traffic congestion, which now seems to be rapidly approaching. It does this, and more. It suggests the necessity for a study of locomotive operation, which on very many railroads has never been made, and it should lead to a careful general investigation of the question, "What are your locomotives doing?"

MECHANICAL CONVENTIONS, JUNE, 1905.

The Master Mechanics' and Master Car Builders' Associations will hold their next conventions at Manhattan Beach, L. I., the Master Mechanics' Association occupying June 14 to 16, inclusive, and the Master Car Builders' Association, June 19 to 21, inclusive. Official headquarters will be in the Oriental Hotel. Information in regard to accommodations and rates may be secured from Mr. J. W. Taylor, secretary of the two associations, 658 Rookery building, Chicago.

STEAM HAMMERS VS. MEN.—I have been in a blacksmith shop for 35 years, and have never yet been able to get a man who is as strong as a steam hammer for making a weld. We go to the hammer with all of our eccentric rods and everything of that description. The men hesitate about welding up ⅞-in. round iron by hand. We have about eight fires to every hammer.—*Thomas Price, before National Railroad Master Blacksmiths.*

(Established 1832.)

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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"AMERICAN ENGINEER" TESTS ON LOCOMOTIVE DRAFT APPLIANCES.

The announcement may now be made that the investigation began by this journal, the first record of which appeared on page 184, in June, 1901, is to be advanced and carried to completion through the aid of the American Railway Master Mechanics' Association.

On page 286 of the July number of last year will be found the report of the committee appointed by the Master Mechanics' Association to co-operate in these tests. This committee consisted of Messrs. H. H. Vaughan, F. H. Clark, R. Quayle, A. W. Gibbs and W. F. M. Goss. This report outlined the tests to be made, and stated their probable cost. The association authorized the executive committee to provide funds necessary to carry out the experiments, when money for such work became available, and the executive committee instructed the secretary to ask members of the association for contributions, which were obtained by the following letter:

"I am directed by the executive committee of the Master Mechanics' Association to ask the assistance of the railroad company which you represent in raising a sufficient fund to enable the association to carry to completion the tests on Locomotive Front Ends, which it has decided are necessary and desirable.

"The experiments carried on by the committee on this subject, which reported at the 1897 convention, decided some of the most important facts in connection with it, and its recommendations have been extensively adopted; but it was unable to complete its investigations, and in 1901 the AMERICAN ENGINEER AND RAILROAD JOURNAL, after considering carefully all the data so far obtained, organized a committee of those interested in the subject, which decided on the lines on which further tests should be directed. All possible assistance was rendered by Purdue University and several interested railroads, and sufficient money was furnished by the AMERICAN ENGINEER AND RAILROAD JOURNAL to carry on an extensive series of experiments.

"At the convention of 1902, the committee of the Master Mechanics' Association was appointed to assist the AMERICAN ENGINEER AND RAILROAD JOURNAL in carrying out these tests, and this committee was instructed to assist in the work and render financial assistance, if necessary, to complete the experiments, so that the laws governing this subject could be finally decided. The tests made at the expense of the AMERICAN ENGINEER AND RAILROAD JOURNAL were extensive, and the further experiments required related chiefly to the determination of the influence of varying diameters of front ends and the efficiency of draught pipes and diaphragms. The necessary series of tests were decided on, the loan of a suitable locomotive promised by the New York Central Railroad through the courtesy of Mr. Deems, and on behalf of Purdue University an offer was made of the free use of their Locomotive Laboratory and such co-operation of their permanent staff as they might find it possible to render. Under these conditions, the estimated cost of the proposed tests was $2,150.

"On application by the executive committee, it was found that it was unable, under the constitution of the association, to grant the necessary money, and, consequently, no work was done which could be reported to the 1904 convention. At the convention it appeared that the funds in the treasury were insufficient to justify the appropriation, and while another year may see the treasury in better shape, it was the opinion of the executive committee that this work should not wait. It is, therefore, in response to their suggestion that this appeal is made, with the hope that the railroad companies of the country will provide the necessary funds to carry on this most important series of experiments.

"I am pleased to advise that through Professor Goss, the committee on this subject has received a renewal of the offer involving the free use of the Purdue University laboratory which was previously made, and that the New York Central Railroad has expressed its willingness to furnish the locomotive required.

"Kindly let me hear from you at an early date, and use your best efforts to interest your company in this matter, which, I am sure, you will realize is of sufficient importance to justify a special appeal for assistance.

"J. W. TAYLOR, *Secretary*."

Mr. Taylor, in transmitting a copy of this letter, says: "I am pleased to state that the response has been very gratifying, that pledges for the full amount are in sight, and that the money will be received in a very short time to enable the committee to complete the tests as outlined in its report to the convention last year."

DEPARTMENTAL BENEFITS.

In the article by Mr. Henderson, on another page, emphasis is given to the importance of general, as distinguished from departmental, results in railroad operation. He quotes a railroad president as saying: "If one department can spend a dollar so that another department can save a dollar and one cent, the expenditure must be made, regardless of the fact that the spending department is increasing its expenses."

Mr. Henderson says this is too often overlooked in department jealousies, and we frequently hear officers say: "My department will not get the benefit of such an expense or improvement, and I am not going to increase my rolls." Superintendents, when an excess of power must be moved, sometimes send out one engine light, and a few minutes later another starts with an overload. This is done to increase the average train tonnage. The superintendent makes a good showing, but at the expense of the locomotives. He deceives himself by his bookkeeping, because he renders it impossible

for the motive power department to keep the locomotives up to their work.

Mr. Henderson touches lightly on this subject, but his articles present a method, whereby the general manager may reckon the cost of such practices, which are far too common. Motive power officers are helping the operating men far more than the operating men are helping the motive power department, and wise general managers will bring the department officials together in order to have the opportunities for the results of good team work fully understood. A school of railroad operation, attended about six times a year by operating, mechanical, maintenance of way and supply department officials, will do wonders for any railroad.

Locomotives are intended to haul trains effectively and cheaply, not merely to keep repairs down to a certain number of cents per mile. Trains are intended to handle passengers and freight efficiently and economically, not merely to show large tonnage per train. Bridges are for the support of the trains and locomotives which will reduce the cost of transportation to the lowest practicable figure, not to merely render the lives of the engineering department officers comfortable.

The motive power men are too generally required to bear burdens laid on them—perhaps unintentionally, perhaps ignorantly—by operating officers who permit overloading and unnecessary delays at stations, and by engineering department officers, who will not allow wheel loads which the bridges are perfectly able to carry with safety.

All this may be overcome by getting the officials together and permitting them to learn that they are not so much officers of departments as employees of the owners of the property.

Imagine the good which would result from a general study of the operation reports by all the officers concerned, say every two or three months!

BOSTON & ALBANY RAILROAD PROGRESSIVE ASSOCIATION.

The inauguration of this association of railroad employees, announced elsewhere in this issue, is important entirely out of proportion to its size and pretentions. It is a voluntary association, on an educational basis, of employees of the motive power department. The company provides quarters and the use of books, drawings and other helps available at the Allston shops. Manufacturers of railway appliances have freely responded to requests for drawings and models of locomotive auxiliary appliances. A course of lectures has been arranged for two evenings per month during the present winter and the membership, originally numbering eighteen, is steadily increasing.

Possibilities of truly great results lie before these men, and every railroad in this country should encourage the faintest sign of desire on the part of locomotive engineers, firemen and shopmen to advance by education, because the great men of this country are as a rule from the rank and file; and nowhere is there so promising a rank and file as on our railroads. It is the boys and men of the locomotives and shops who are prepared to educate themselves and are eager to take and even make opportunities for progress to whom we are to look for recruits for the leadership of the future. This Boston & Albany Association is small in itself, but it may be made a power of influence and advancement. The members do not dream of the good it may be made to do them and the community and the officials do not dream of the possibilities of improved efficiency through the educational development of thousands of men of the character and intelligence of those performing subordinate service on American railroads.

The esprit de corps of railroad employees and the faithful devotion which leads them, like those who follow the sea, to do difficult service for the love of it, should be considered thoughtfully by those who are responsible for railroad management of the immediate future. Education and progressive advancement of the men who run trains cannot be overlooked in plans for the future.

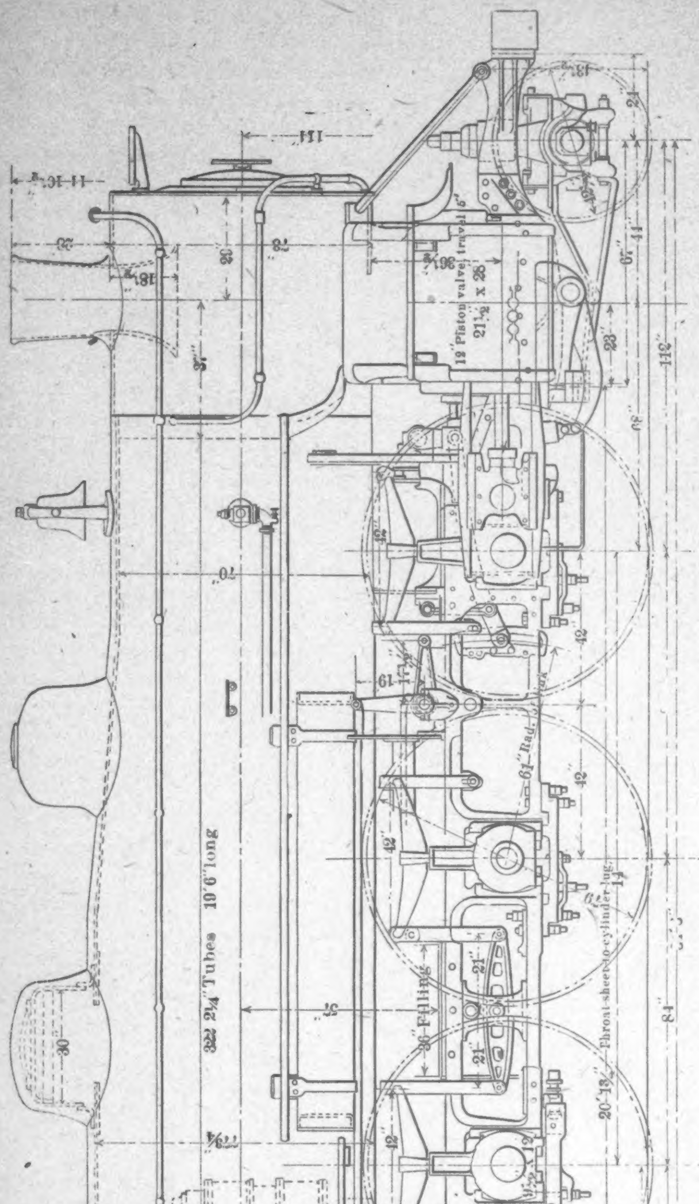
Why does not every American railroad hurry to provide facilities for this improvement when the men are ready, open-armed for them, and are prepared to do their part?

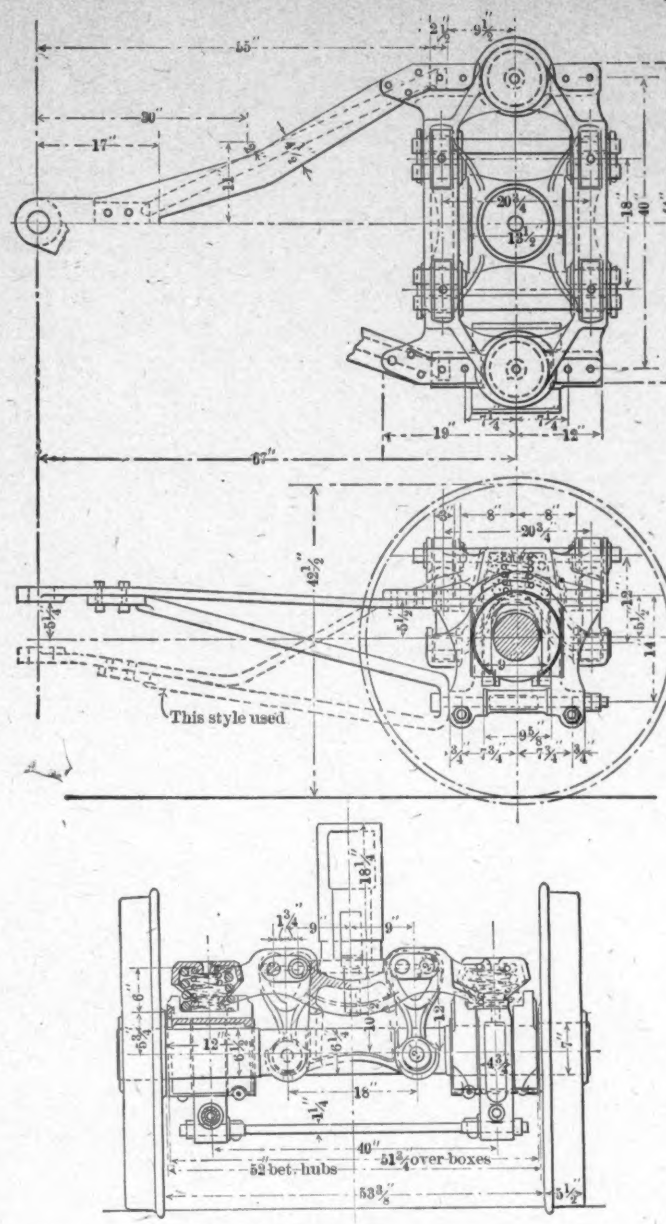
What can an educated engineer save? What can an educated fireman or shopman save? What can a thousand or two or ten thousand of them save?

This is an interesting period in American locomotive development. Never before has so much interest been shown in improved valve gear, superheating, four-cylinder balanced compounds, in the most favorable proportions of great area and heating surface. Everybody who is making any progressive steps is talking about them, and wondering how much there is in each of these factors. This is the time for the railroad mechanical engineer to show his value, especially on large roads and groups or systems of roads. When the railroads are building up their equipment so fast, to meet to-day's requirements, it is difficult to do any experimenting, but nevertheless experimenting should be done. A general manager told the writer that 54.4 per cent. of the locomotives on his road were new within the past five years. The total number now in service is over 650. That road has been wise in avoiding radical departures, but it will be unwise to delay longer an effort to ascertain the possibilities of improvements which now lay at hand waiting to be tried. Such a road should set its mechanical engineer to work embodying superheating and balanced compounding in new designs which will include as many as possible of the details at present in use, such as driving boxes, trucks and parts which are already in use and known to be satisfactory. Undoubtedly the locomotive builders would co-operate in work of this kind. In fact, they are doing so in certain well-known cases.

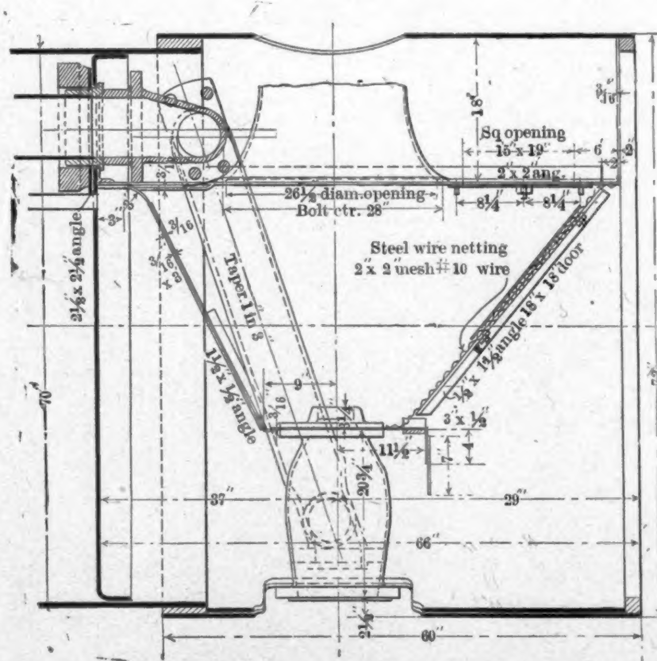
The problems of the organization and operation of a railroad blacksmith shop are very different from those met in the other departments. The foreman is to a greater extent thrown on his own resources and the success of the shop depends quite as largely on his ingenuity in devising special devices and tools, such, for instance, as can be used in connection with steam hammers and bulldozers, as on the proper handling of his men. The McKees Rocks blacksmith shop of the Pittsburg & Lake Erie Railroad is notable because of its large output, considering its size, and the low cost of production. The success of this shop is very largely due to Mr. McCaslin's method of handling the men and the special tools and devices which he has devised to increase the output and decrease the cost of production. Because of his success, the article by him in this issue will be specially valuable to those interested in this class of work.

The ten water softener plants on the Pittsburg & Lake Erie Railroad have been in service about a year with remarkable results. Because of the drought in the Pittsburg district, the river waters have become badly polluted by the refuse from the coal mines and mills. Although the other railroads in this district are having a great deal of trouble with their locomotives, because of the impure water, the Pittsburg & Lake Erie Railroad has had practically no trouble, and in fact has been able to loan power to less fortunate neighbors. The credit for this very satisfactory condition is due to the water softener used and to the general method of control, which keeps all these plants under a strict supervision, and yet with a minimum cost for inspection. The chemist, or inspector, was the only man added to the company's pay roll because of the installation of these plants. The system of control has been carefully worked out by Mr. G. M. Campbell, electrical engineer of the road, and this, with the results from a chemical standpoint, will be described in a series of articles by him, the first of which appears in this issue.





LEADING TRUCK.



"AMERICAN ENGINEER" FRONT END.

SIX-COUPLED PASSENGER LOCOMOTIVE, 2—6—2 (PRAIRIE) TYPE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

H. F. BALL, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*

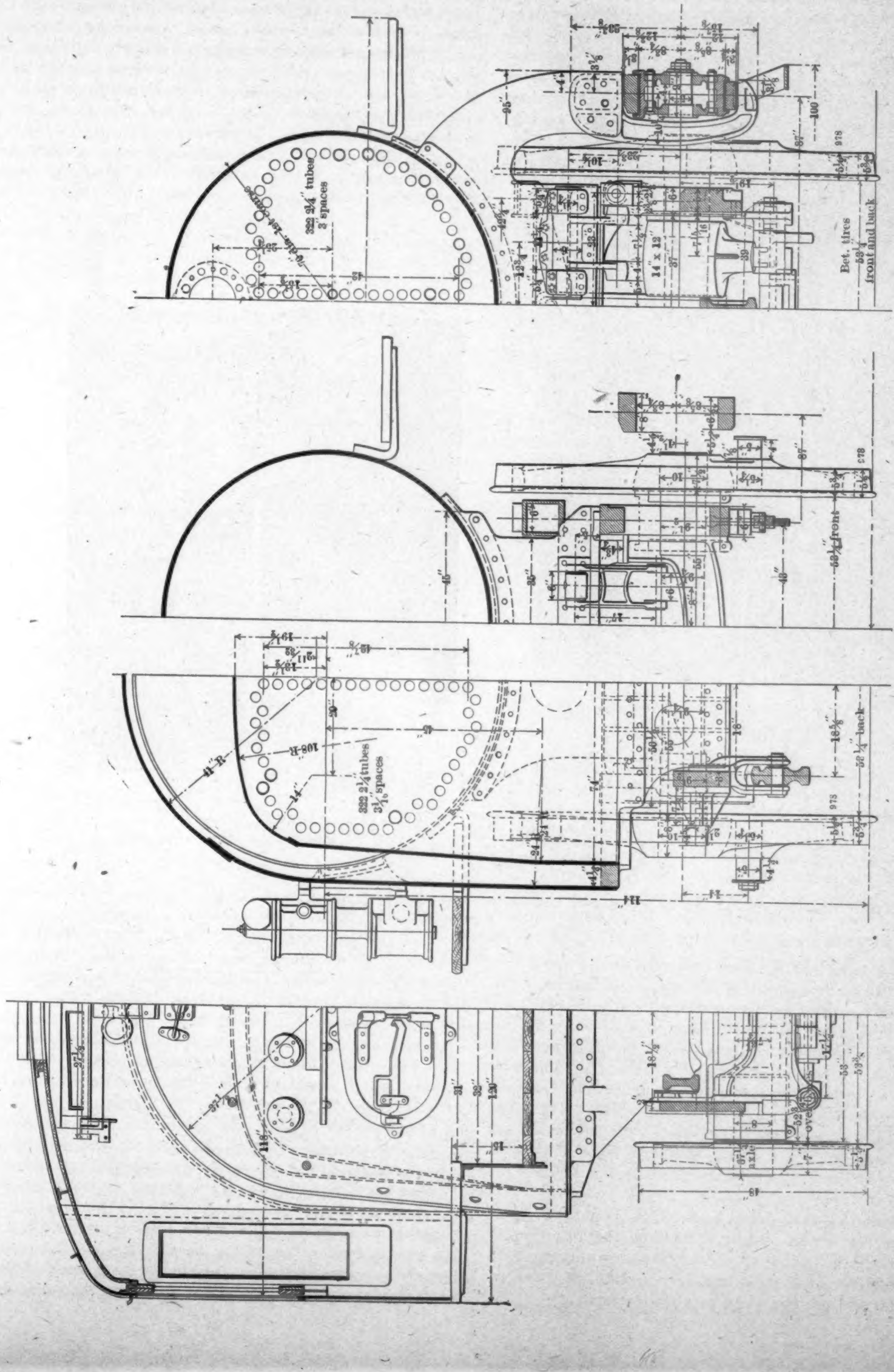
POWERFUL PRAIRIE TYPE LOCOMOTIVES.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

A general description of these locomotives appeared on page 413 of the November number, and a description of the frames on page 479 of the December number of this journal.

The accompanying engravings show a side elevation, sections, the leading truck, stack, and the arrangement of the front end. Little additional description is required, as the engravings explain themselves.

The cross sectional views show the construction of the guide yoke, rocker box, the rocker arms, the suspension for the transmission bar, and cross section of the equalizer under the firebox and the double fire doors, with one large opening through the back head. The large cast steel equalizer referred to is not symmetrical in section, as the lower or tension member of the I beam is larger than the upper or compression



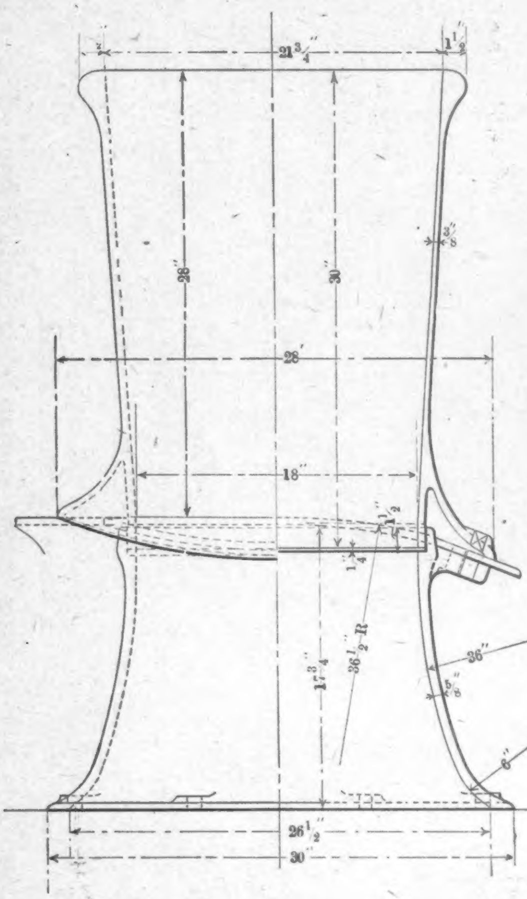
CROSS-SECTION THROUGH BOILER AND RUNNING GEAR.

SIX-COUPLED PASSENGER LOCOMOTIVE, 2—6—2 TYPE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

member, which is done for the purpose of decreasing the stresses per sq. in. in tension to an unusually low figure. These locomotives are fitted with 14-in. piston valves.

These locomotives are fitted with the Elvin grease lubrication for the driving boxes. The rod cups are also fitted with grease lubricators. The links are 3½ ins. wide and the valve motion stresses are in direct line with all pins in double shear. The leading truck, shown in one of the engravings, is made very compact and simple by the use of cast steel and by placing coil springs over the boxes. This truck has 8 ins. of lateral motion. The trailer truck is of the improved Player type with equalizers instead of leaf springs over the boxes. Coil springs are used at the rear ends of the equalizers and these are fitted with McCord spring dampeners. This truck gives space for an unusually good ash pan clearance. It provides a total lateral motion of 9 ins., which is required on account of the long wheel base.

The stack and front end are arranged in accordance with the American Engineer tests on locomotive draft appliance, the results of which have thus far been very successfully applied on this road. The stack is shown in one of the illustrations. The boiler has an outside diameter of 70 ins. and has the gusset bracing, characteristic of the Brooks works. Tate flexible stay bolts to the number of 174 are used in the front and back corners of the fire box, all the throat stays and a number in the back head being of this variety. These locomotives have 322 2¼-in. tubes 19 ft. 6 in. long, with 13-16-in. bridges and 3 1-16-in. space at the back tube sheet. The spaces at the front tube sheet are 3 ins. Each engine is fitted with three standard blowoff cocks, one in each side and one in front of the firebox.



STACK DESIGNED ACCORDING TO "AMERICAN ENGINEER" FORMULA.

It is noteworthy that these locomotives weigh practically the same as the largest freight engines on this road, which were illustrated on page 12 of the January number, 1904. These locomotives have gone into service with excellent results thus far and promise to be very satisfactory.

NEW MOTOR SPEED CONTROLLER.

The rheocrat is a new type of motor speed controller, which may be used with any standard motor, and while its design is radically different from the ordinary type of controller, its size and external appearance are much the same, as will be noted by reference to the illustrations. Its principal advantages are the uniform and minute gradations of speed which it furnishes over a wide range, the ability to stand abuse under severe usage, its economy of operation, and the fact that the motor maintains its speed regardless of the load and that the torque is constant at the lower speeds over a range of about 3 to 1, which is obtained by changing the effective voltage at the motor. This range of 3 to 1 may be increased by the addition to the system of field control, thus permitting a range of speed of from 3½ to 1 up to 5 to 1, and even higher ratios in special cases.

The principle of the system consists, briefly, in the intermittent connection of the working circuit with the supply circuit. That is, in a cycle of operation, the supply circuit is connected only a part of the time, the result being that the effective voltage at the motor, as measured by a voltmeter, is less than the supply voltage. The time of connection with the supply circuit can be varied, thus enabling the motor to be supplied from constant-potential mains with a voltage varying in value to accord to the speed desired. The rheocrat has been very severely tested for a considerable length of time, and the form shown in Fig. 1 has been adopted as standard. The essential part of the apparatus is the vertical commutator, which resembles closely the commutator of an ordinary dynamo. This commutator, or "interrupter," is driven by a small motor in the lower part of the case, and revolves at a constant speed of about 1,200 r.p.m. The terminals of the interrupter are at two groups of carbon brushes held in reaction brush holders, which are in contact with the interrupter along diametrically opposite lines. The supply circuit furnishes an impulse to the working motor only when a certain pair of bars, called contact bars, which are diametrically opposite but cross connected, pass under the collector brushes. By means of mechanism operated from the controller cylin-

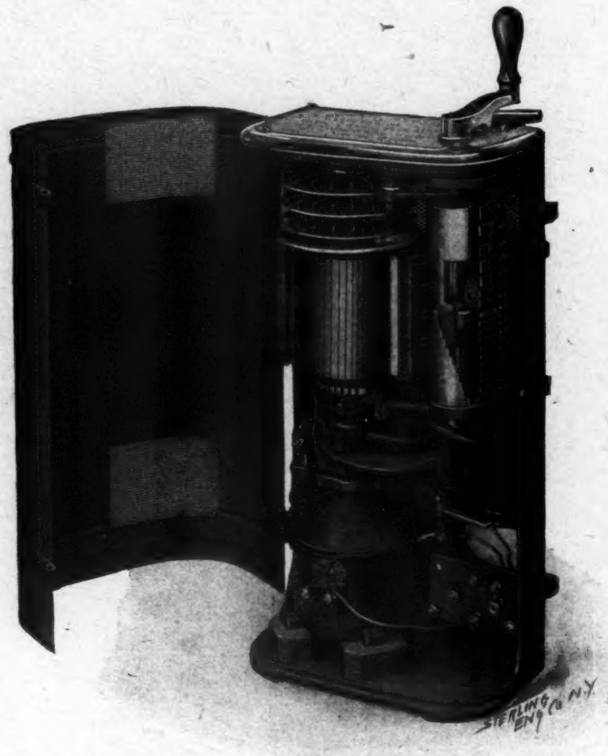


FIG. 1—5-H-P., TYPE A, RHEOCRAT.

der, any given number of these bars may be connected or disconnected to the pair of contact bars, thereby varying the length of time during which the supply circuit is connected with the motor circuit. The working limit of voltage variation by this means lies between the full voltage of the line and something less than half the voltage of the line, which latter voltage is given when the least number of bars are in circuit, and therefore when the time of interruption is longest.

A diagram of the wiring connections is shown in Fig. 2. The detached group of contacts to the right are for reversing the motor field. Of the two groups of contacts in line, the upper is for the interrupter control and the lower for the field control. The coil to the right represents a circuit-breaker acting directly as an under-voltage breaker, and also, through the relay shown at the left, as an overload breaker. Current cannot be put into the motor again after the opening of this overload switch without returning the handle to its off position. The overload release acts if the controller handle is moved too rapidly from its slow to its fast speeds, and so protects the motor from injury as a result of careless use.

In turning the controller handle from the starting point the following is the order of operations: First, the interrupter motor is cut into circuit; next, the working motor is connected with the supply circuit with its field winding directly across the circuit and the armature in series with the interrupter, of which only the first pair of contact bars is now active and the impressed voltage consequently a minimum, thus starting the working motor at the lowest speed. A further motion of the controller handle increases the impressed voltage, thereby increasing the speed of the working motor.

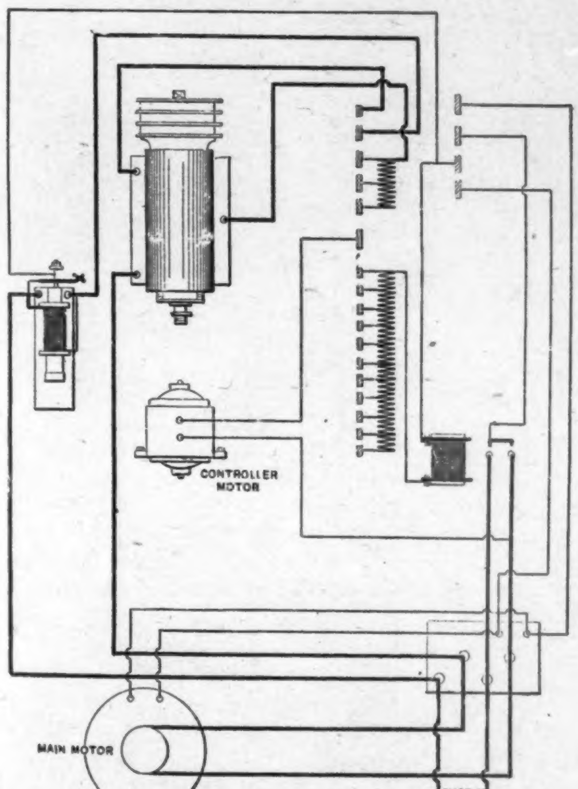


FIG. 2—WIRING DIAGRAM OF THE RHEOCRAT.

The next movement of the handle cuts out the interrupter, when the working motor runs on full line voltage. Further movement of the controller handle introduces resistance in the field circuit of the working motor, thereby increasing its speed, provided the working motor is designed for field control.

The design of the controller cylinder and interrupter is such that the changes in speed are made very gradually, and not by steps, causing abrupt changes. To provide for sparking at the brushes, which otherwise would take place upon the interruptions of the line connection, inductance coils connected between several of the narrow breaking segments in two groups, follow the pair of contact bars in passing under the contact brushes. In Fig. 1 these coils will be observed in the form of discs above the commutator or interrupter. By this means sparking is reduced to a negligible quantity. To reverse the motor, it is simply necessary to move a small switch, shown under the controller handle, to its opposite

FIG. 3—31-IN. ROGERS MACHINE TOOL COMPANY BORING MILL AND RHEOCRAT.

position, when the entire speed range in the opposite direction becomes available. The reversing switch is interlocked with the main controlling cylinder, so that it cannot be thrown except when the controller handle is at the off position.

The rheocrat can be used with any standard motor and with any system of wiring. A separate starting box and circuit breaker or overload release are not required, as these features are embodied in the controller itself. On such machine tools as lathes and boring mills, a constant torque is very desirable; for instance, it may be necessary to do a job of facing on a lathe, and while the size of the cut will remain the same, in order to keep the cutting speed constant, and thus obtain the greatest efficiency from the machine, the motor speed may have to be varied over a wide range. The close regulation which can be obtained by the use of the rheocrat is shown by the following tests.

These were made on a 31-in. Rogers Machine Tool Company boring mill, shown in Fig. 3, driven by a General Electric 3-h.p. motor and rheocrat controller. Armstrong-Whitworth "A. W." high speed tool steel was used.

TEST 1.

Heavy cast iron flange, 15½ ins. diameter faced to 8 ins. diameter.
Time required, 3 min. 38 sec.
Maximum cutting speed, 125 ft.
Minimum cutting speed, 115 ft.
Average cutting speed, 120 ft.
Feed, 48 cuts per in. Depth of cut, ⅛ in. 3.42 h.p. at boring mill pulley.
Estimated h.p. input about 3.73 (electrical.)

TEST 2.

Standard cast iron pipe flange, faced 15½ ins. to 9 ins. diameter.
Time required, 2 min. 8 sec.
Maximum cutting speed, 78 ft.
Minimum cutting speed, 72 ft.
Average cutting speed, 75 ft.
Feed, 16 cuts per in.
Depth of cut, ⅛ in. Same tool used as in No. 1 test without being reground.
6.1 h.p. input to motor (electrical).
4.92 h.p. delivered to the boring mill pulley.

TEST 3.

Outside diameter, 24½ ins., faced to a diameter of 12¾ ins.
Time required, 3 min. 58 sec.
Maximum cutting speed, 125 feet per min., momentarily only. Reduced because the motor would not stand the excessive overload.
Reduced maximum cutting speed, 102 ft. per minute.
Minimum cutting speed about 98 ft. per minute.
Average cutting speed, 100 ft. per minute.
Feed, 16 cuts per in. Depth of cut, ⅛ in.
Tool uninjured.
6.44 h.p. input to motor (electrical).
5.28 h.p. delivered to boring mill pulley.

The rheocrat is made by the American Electric & Controller Company, 12 Dey street, New York City, of which J. D. Maguire is president and Elmer A. Sperry, consulting engineer.

THE BALTIMORE & OHIO CAST IRON WHEEL.

Those present at the Master Car Builders' convention last June will remember the discussion by the Baltimore & Ohio representatives of the report of the committee on cast iron wheels (see AMERICAN ENGINEER, July, 1904, page 287). In response to a request, Mr. J. E. Muhlfeld, general superintendent of motive power of that road, has supplied drawings and information for a description of the Baltimore & Ohio design of 33-in., 750-lb. wheels for 50-ton cars.

The Baltimore & Ohio officers consider that this design meets the requirement of severe service, under conditions of operation and braking of large capacity cars, better than any other, "and where the Master Car Builders' Association recommended design has failed."

The chief characteristics of this design are the arrangement and location of the plates, the contour of the tread and the increased depth of metal in connection with the reinforcement of the brackets at the back of the flange. The tread is slightly conical, and this has been found to eliminate flange wear to a considerable extent on steel-tired wheels. When flange wear is prevented, the stresses in the flange are to a large extent decreased, which tends to eliminate the development of seams at the throat of the flange, due to flange friction and the heating of the wheel in curving. The plates are made to join the tread at the outer rim at an angle, and not in a direct plane of the wheel. The angularity of the plate and the corrugation render the plate more flexible, and to a large extent prevent the cracking of the plate from the heat of the brake shoes. The plate and the large amount of metal brought to the outer edge of the rim answers a three-fold purpose:

First—It prevents the outer edge of the rim from chipping off.

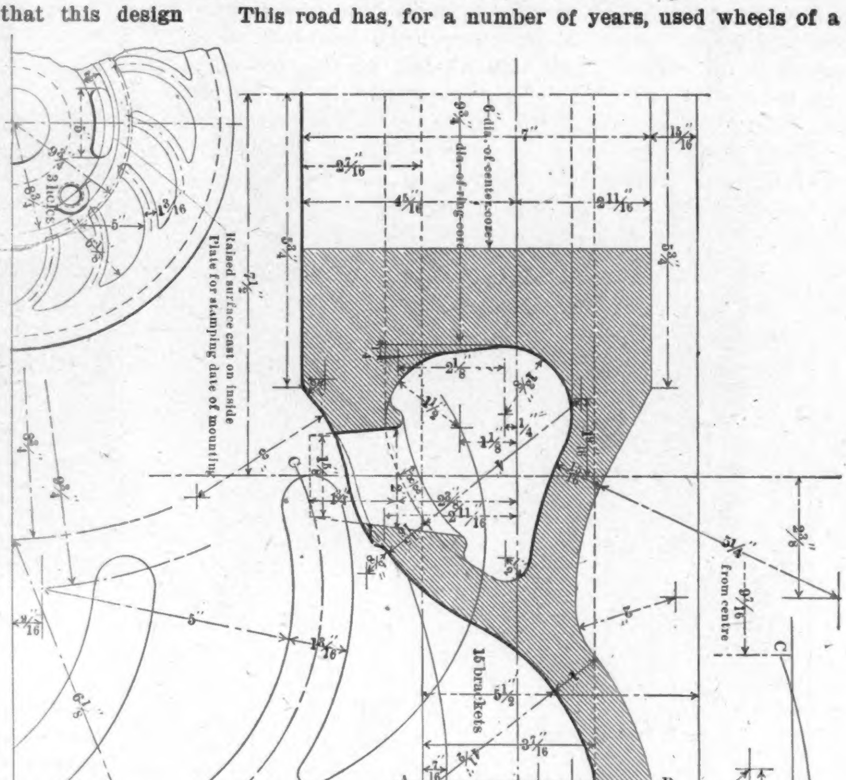
Second—The body of metal prevents the wheel from being completely chilled at this point, where the chilling effect is not needed.

Third—The body of metal at this point, where the brake shoe happens to become shifted over the edge of the wheel and applied, takes off the heat from this portion of the wheel and prevents cracking in the tread, which is produced in the M. C. B. type of wheel under similar conditions.

Another feature is that the reduced metal above the rail contact increases the chilling effect where the greatest wearing capacity is desired, and the increased metal at the back and base of the flange and at the rim reduces the chilling effect where less wear and greater strength of metal are required to take care of the brake shoe and flange friction. This wheel is well braced by the brackets at the back of the flange, and increased metal is provided at this point, which tends, not only to strengthen the flange, but also to draw the chill and back up the throat of the flange with more gray iron.

To show the benefit of the plates as arranged in this design with regard to withstanding the braking effect, a number of cars, which were extremely hard on wheels because of large weight per wheel, were equipped with wheels of this design. These wheels in going down very heavy grades were burned on the treads in a short time, the chill became disintegrated and large pieces fell out; but out of the wheels under 20 cars none were cracked. Later, these wheels were replaced by others of the M. C. B. design, and immediately many of them had to be removed on account of cracked plates.

This road has, for a number of years, used wheels of a de-



THE BALTIMORE & OHIO CAST IRON WHEEL.

sign similar to the one illustrated, with the exception of the contour of the tread, and the number of cracked plates was small. Those which cracked were extremely hard. This new design has been in service since February, 1904, and at the end of September, 1,000 of them were in service. This is now the standard wheel of the Baltimore & Ohio Railroad. This tread contour has been used on locomotive tires for the past year

with very satisfactory results. The cast iron wheels with this contour have not been in service long enough to give sufficiently definite information. Further tests are being made by equipping 50-ton steel hopper cars with four B. & O. design wheels under one truck and four M. C. B. wheels under the other. Similar tests, comparing B. & O. cast iron and rolled steel wheels, will be made.

Because of the severity of its service, this study of wheels on the Baltimore & Ohio is exceedingly important, promising valuable information on the problem of wheels under heavy cars.

HOLLOW HEXAGON TURRET LATHE.

A powerful turret lathe, which is designed for using the high speed tool steels up to the limit of their efficiency, is shown in Fig. 1. It takes bar stock up to 3⅝ ins. in diameter, will turn up to 36 ins. in length and has a swing of 24 ins. over the bed. In addition to its great strength and rigidity, the most noticeable features are the wide range of speeds and feeds which are instantly changeable, the rapidity and convenience of manipulation and the improved high speed turning tools.

When belt driven, 12 spindle speeds are provided, ranging from 18 to 190 r.p.m. in geometrical progression and giving about 100 ft. surface speed on diameters from 2 to 3⅝ ins. advancing by eighths. The belt cone is geared 3½ to 1 and back geared 13 to 1; the back gears being engaged and disengaged by friction clutches. The machine illustrated is driven by a Bullock 3 to 1 motor, direct connected to the back gear shaft, and rated at 15 h.p. The head and bed of the lathe are cast in one piece.

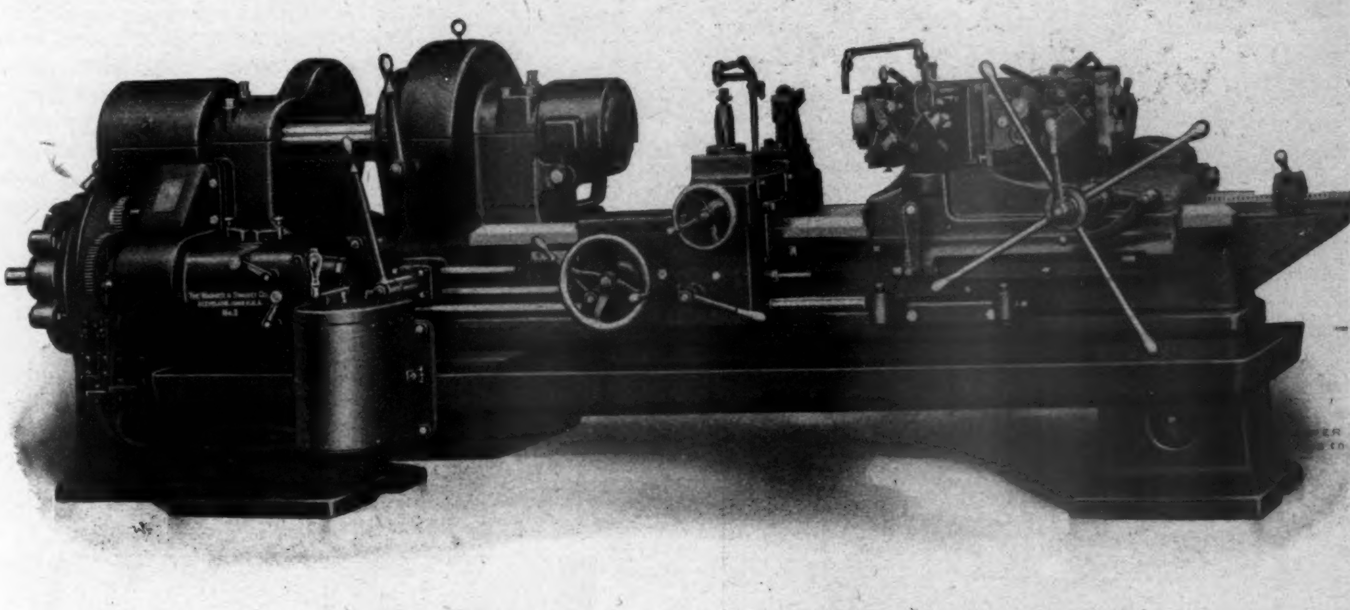


FIG. 1—NO. 3 HOLLOW HEXAGON TURRET LATHE.—WARNER & SWASEY COMPANY.

Bar stock of any shape is handled by the automatic chuck and power roller feed. The chuck is held in the head of the spindle, which is forged solid, thus bringing the chuck jaws close to the front spindle bearing with a minimum of overhang. The chuck is operated by the long lever in front of the head, working through a system of compound levers, which give a powerful movement for closing the jaws. The jaws are quickly changed for different diameters of stock, and a single screw adjusts the roller feed and the guide fingers. The roller feed is operated by the same lever as the chuck, and since it does not depend upon the spindle for its power, the stock can be fed equally well at any speed.

The turret saddle slides directly on the bed, eliminating all overhang. It is gibbed to the outer edge of the bed by flat gibs throughout its entire length. There are four changes of feed in either direction, varying from 20 to 100 per in., and screw-cutting feeds for leading on dies. The feed rack is located on top of the bed midway between the V's and is as high up as possible, thus greatly reducing the stresses as compared to those in the construction where the rack is placed at the side of the bed. The automatic feed is thrown in or out by the single curved lever at the right of the saddle near the turnstile. Power quick traverse in either direction is provided for the rapid handling of the turret, and for indexing, the movements being controlled by the lever in front of the turnstile. The independent adjustable stops for each face of the turret are located in front of the saddle, where they are easily accessible for changing and adjusting, and at the same time are well protected from chips and dirt.

The hollow hexagon turret, shown in Fig. 3, is 18 ins. across the flats and has a broad bearing on the carriage. It revolves on and is kept central by a large taper bearing, with ample provision for taking up wear, and its trussed form provides a rigid support for the tools, resisting end thrust as well as torsional strains. The turret being hollow, allows tools to be

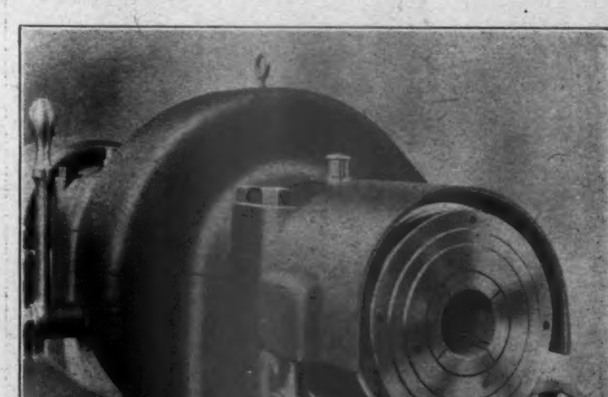


FIG. 2—SPINDLE END AND AUTOMATIC CHUCK.

bolted in place from the inside, thus leaving the entire outer surface available for tools and their parts. The index is nearly the full diameter of the turret, and the lock bolt is placed directly under the working tool. The backward movement of the saddle gives the turret its partial revolution, which begins as soon as the working tool is free from the stock. The adjustable stop shown at the extreme tail end of the machine is clamped to the feed rack and governs the position of the saddle at the time when the turret begins to revolve.

The tool equipment regularly furnished is adapted for a great variety of work, including thread-cutting. The universal turners are especially adapted for using high speed tool steels. One of the special features of the tool is the roller back rest, shown in Fig. 4, which eliminates the excessive friction due to the high speeds, and the improved construction and great rigidity of the tool insure the highest degree of accuracy. The holder which carries the cutting tool swings about a stud, and can be easily and accurately adjusted by means of a screw, while an eccentric lever provides means for quickly withdrawing the tool from the work.

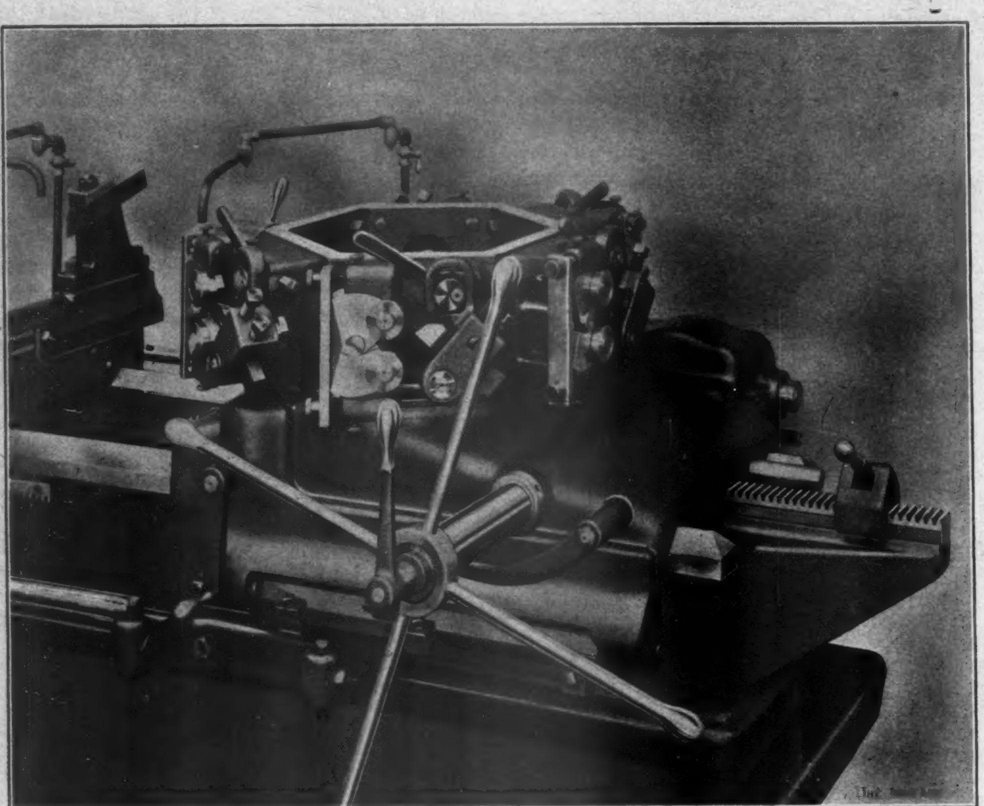


FIG. 3—HOLLOW HEXAGON TURRET AND TOOL EQUIPMENT.

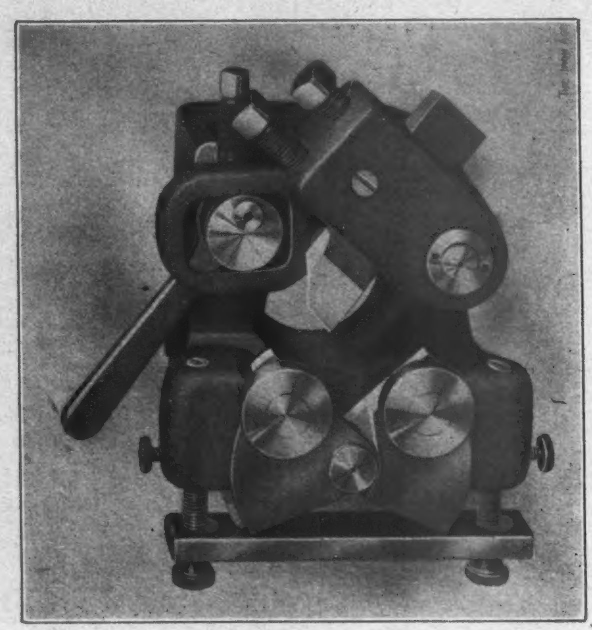


FIG. 4—UNIVERSAL TURNER WITH ROLLER BACK REST.

The carriage has 30 ins. traverse longitudinally and 10 ins. cross motion, both with four changes of feed in either direction. The longitudinal feeds vary from 24 to 120 and the cross feeds from 62 to 312 per in. Both feeds have adjustable automatic trips. There are 2 stops, with automatic trips, for the longitudinal travel, and the cross feed screw is fitted with a graduated dial. The front of the cross slide is equipped with a suitable tool post for holding forming and turning tools, while the rear end carries a holder for cutting-off blades. All of the feeds are gear driven, and are quickly and easily changed by simply shifting a lever in the feed box, which is conveniently located in front of the head, and is shown in Fig. 5. The turret and carriage feeds are independent of each other.

The pan and oil revervoir are large, and a geared oil pump, which operates in either direction, delivers a copious flow of oil to the cutting tools for both the turret and carriage, through two systems of piping. All gears and other revolving parts are covered by suitable metal guards.

This machine, which has a net weight of about 12,000 lbs., is made by the Warner & Swasey Company, of Cleveland. It is known as No. 3 and is the largest of three sizes of hollow hexagon turret lathes made by them.

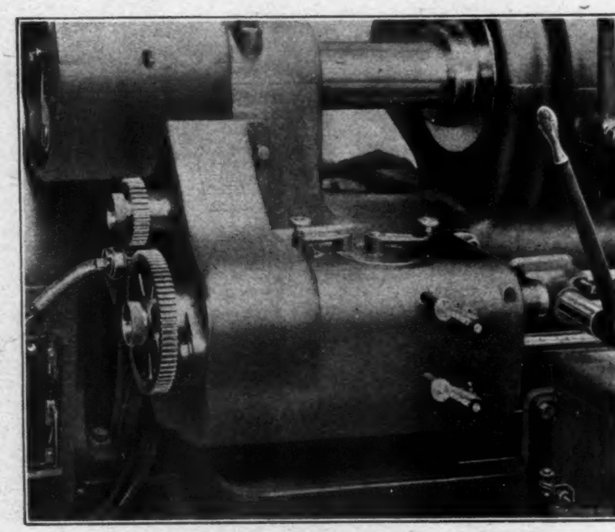


FIG. 5—FEED BOX FOR TURRET AND CARRIAGE.

ABLE SMOKE JACKS.—We have smoke jacks with throats about 12 to 14 ft. long, lengthwise of the pits, so that, no matter what position the locomotive is in, there is an open jack above it, so we have very little trouble from smoke under any conditions.—*A. R. Raymer, before Western Railway Club.*

CLASSIFICATION OF LOCOMOTIVE REPAIRS.

CANADIAN PACIFIC RAILWAY.

On page 141 of this journal for April of last year, appeared a discussion of locomotive repair records, but at the time the name of the road concerned was not given. It may, however, now be stated that Mr. H. H. Vaughan, then of the Lake Shore & Michigan Southern Railway, was the originator of that system, which has since been developed by him, as superintendent of motive power of the Canadian Pacific, into the new system which he has put into effect on the latter road and describes as follows:

The classification of repairs in general use employs very commonly 3 to 5 numbers, which are frequently accompanied by suffix letters indicating whether an engine has had heavy, medium or light machinery repairs, whether tubes have been reset or not and the nature of the firebox work performed. In order to clearly describe the various combinations that may exist, this system becomes complicated; and in the scheme previously referred to an attempt was made to simplify it by dividing the machinery repairs into two classes, viz.: Class 1 and Class 2 machinery repairs, No. 1 indicating engines receiving general overhauling, and No. 2 indicating a light overhauling but heavier repairs than those commonly termed running repairs, and employing a suffix letter to show whether tubes were reset or not. In the system now described this classification has been amplified and made more distinct and serviceable, and while slightly more complicated, is, when once understood, perfectly clear and easy to employ.

The same idea is carried out of separating running repairs, which are strictly maintenance charges and which constitute work which must be performed on an engine from time to time to keep it in normal condition, from shop repairs, which either constitute a general overhauling of the engine, changing it from a rundown and unworkable condition into a repaired and, so far as its operation is concerned, practically a new engine, or repairs which are done to it between its general overhaulings and enable it to keep the road for a longer time than would be the case had it only received running repairs. A distinction between shop and running repairs is a difficult one and was not distinctly settled in the Lake Shore report. On the Canadian Pacific a distinction has been made by calling repairs which cost less than $100 for labor "Running Repairs," and those on which the amount of labor exceeds $100 "Shop Repairs." Additional classes of repairs, such as "Wreck" and "Defect," are also introduced. Wreck repairs for the reason that they are not chargeable to the maintenance of locomotive account under the Interstate Commerce Commission classification, and defect repairs in order to separate from the maintenance account that class of repairs and expenditures such as those due to broken piston rods, broken spring hangers, etc., which, while chargeable to maintenance of locomotives are not repairs that it is fair to hold the division officers responsible for. Running repairs are evidently an expenditure that is every month properly proportional to the locomotive mileage made during that month, whereas the cost of shop repairs in any month does not depend upon the mileage run, but on the amount of work put on the power in the shops to improve its condition, or, as it may be termed, to the mileage shopped.

Over a considerable period it would be satisfactory to regard the mileage shopped as an aggregate of the mileage made since last general overhauling by each engine receiving general overhauling during that period. In the long run, if the condition of power is maintained at a normal level, the mileage shopped must be equal to the mileage run. If, however, the condition of power is allowed to deteriorate, it would not be as great, and on the contrary, if the condition were built up it would be larger. It is important, therefore, to know in each month, the mileage shopped, and this is preferably based on the engines receiving a general overhauling of machinery; it is also necessary to know the number of engines receiving complete sets of tubes in order to determine the condition of the engines as regards tube mileage. In the classification of repairs described, these overhaulings are very closely determined, and additional information is easily noted by means of

FORM 1.

CANADIAN PACIFIC RAILWAY COMPANY.

Report of engines out of service over twenty-four hours for running repairs during period ending 190

Station.	A Engine Number.	B Class of Repairs.	C Taken Out of Service.	D Taken into Shop.	E Expected Out.	F Turned Out.	G Days in Shop.	H Nature of Repairs.

(This form has 30 blank lines under these headings.) Signature..........................

Running repairs are those estimated not to exceed $100 for labor.
Wreck and defect repairs are to be shown on this form when cost is estimated not to exceed $100 for labor, and when not accompanied by shop repairs.
Under class of repairs show whether running, wreck or defect.
Letters to be used to wire information when so instructed.
This form to be sent in on 7th, 14th, 21st and end of each month to master mechanic.

FORM 2.

CANADIAN PACIFIC RAILWAY COMPANY.

Report of engines out of service over twenty-four hours for shop repairs during period ending 190

Station.	A Engine Number.	B Shop Repairs. Mach. Tubes. Firebox.	C Wreck or Defect.	D Taken Out of Service.	E Taken Into Shop.	F Expected Out.	G Turned Out.	H Days in Shop.	J Remarks.

(This form has 30 blank lines under these headings.) Signature..........................

Shop repairs are those estimated to exceed $100 for labor.
Wreck and defect repairs are to be shown on this form when costis estimated to exceed $100 for labor, or when accompanied by shop repairs.
Under remarks give nature of wreck or defect repairs.
Letters to be used to wire information when so instructed.
This form to be sent in on 7th, 14th, 21st and end of each month to master mechanic.

FORM 3.

CANADIAN PACIFIC RAILWAY COMPANY.

Summary of engines out of service over twenty-four hours for all repairs during period ending 190

Station.	Number of Shop Repairs. Machinery. No. 1.	No. 2.	No. 3.	Tubes. No. 1.	No. 2.	Fire Box Sheets.	Average Days in Shop.	Mileage. Machinery.	Tubes.	Number with Wreck.	Defect.	Running.	Total Days Out of Service for Running Repairs.
(This form has 30 blank lines here.)													
Total													

the forms illustrated, even for a considerable number of engines.

In order to avoid complication, different forms are used for reporting engines out of service for shop and running repairs, and wreck and defect repairs are reported on the same blank as running repairs where of about the same value, viz., $100 for labor. This distinction is made on the estimate of the locomotive foreman, as it is evidently not very important should an occasional error be made, and it is easy to detect any mistake in this matter from the monthly accounts. Basing the dividing line on the estimate, the storekeeper and the accountant knows the moment an engine is in the shop whether it is held up for shop or running repairs and can arrange his accounts accordingly. It will be noted in making the summary, which can be made weekly or monthly, no attention is paid to whether an engine receiving Class 1 machinery is the same engine that received Class 1 tubes or not, as all that it is necessary to know is the number of general or partial overhaulings of machinery, complete or partial sets of tubes and firebox sheets that have been turned out during the month.

It will be noted in this classification, a distinction is made between engines receiving light repairs with tire turning and those receiving light repairs without tire turning. A classification is also made for engines receiving partial sets of tubes, and it will be seen that by the means of three figures a very close idea can be given of an engine receiving any kind of shop repairs and whatever way they were combined. Form No. 1 is for running repairs and Form No. 2 for shop repairs. The Form No. 3 also gives a rough statement of the output of each shop during the month, and the total gives the output of all shops on the road. This form can be prepared within a few days after the end of each month and is certainly of the greatest use in watching results obtained from time to time.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

PARIS.

The visit of the editor of this journal to the motive power chief of the Northern Railway of France should interest the reader. It touches the methods of handling locomotives and shows why these people have such efficient service. It shows how this road operates locomotives on from 17 to 19 lbs. of water per h.p. per hour. This road is prominently mentioned as more time was spent upon it than upon the others and because it is representative of French practice.

Mr. du Bousquet speaks no English, and my French, learned at school, is too out of date for use now-a-days. I had several letters of introduction and was personally introduced by Mr. Tachard, of the Societe Alsacienne de Constructions Mechaniques, who proved a most efficient and courteous interpreter on several occasions. When told of my general interest in four-cylinder compounds and of the very large amount of information wanted, Mr. du Bousquet said with open-handed gesture: "We shall be pleased to tell and show anything we have and to furnish anything we can get concerning our work." He at once arranged a trip on locomotive No. 2645, which had been in service continuously for two years since leaving the builder's works at Belfort and had made 186,942 kilometers or 116,000 miles. This engine was selected in order to give an idea of the work done under unfavorable circumstances. The visitor was then taken in hand by Mr. Roderigue, chief assistant to Mr. du Bousquet, and by Mr. Koechlin, chief draftsman. These gentlemen showed very great familiarity with all of the details touched upon in the conversation and with them a profitable time was spent over the drawings and records of the engines hauling the fast trains between Paris and Calais. This road has most active competition for English-Continental business and this has had the effect of making it one of the most progressive of French roads.

Engine No. 2645 is an Atlantic type. It was put on a morning train specially for my benefit; the return was also arranged so that the entire trip of 370 miles could be made on one engine, and furthermore one of the best engineers on the road was in charge. These people have nothing sufficiently severe to say of pooling. On brass plates at the sides of the cab the names of the engine crew appeared. Engineer Huart, Fireman Vassal. The men take great interest in their work and the fact that their names are closely associated with the engine leads them to assume responsibilities for its condition which are not seen under the pooling system. On the trip to Calais the sander gave trouble; on the return journey it worked perfectly. The sand was damp and as the rail was very bad the engineer took no chances but saw to it personally and had the sand taken out, the pipes cleaned and dried and dry sand supplied. This is a small item, perhaps, but it illustrates a point that seems important. The engineer remained with the engine during his two hours "lay-over" to make sure that everything was done right. He watched the fire cleaning and everything that was done. He also personally inspected the machinery. His premium was at stake and he wanted the cash which he might earn by being on time and by saving fuel. This premium matter will be referred to again as it plays an important part in locomotive performance in France. When the engine was known to be properly cared for and the sander fixed the engineer had ten minutes left for his dinner. Contrast this with the indifference of our engineers at home. On the arrival of every passenger train at Calais the roundhouse foreman meets the engineer at his engine to ascertain the condition of the engine and the amount of work required before the return run. Contrast this also with our practice. Our roundhouse foremen do not have time to do such things.

In spite of the fact that we did not speak the same language, the engineer and the writer were busy all the way talking in signs and grimaces. The engine was also busy, and the fireman. Leaving Paris at 9.45 a.m., the train was scheduled to arrive at Calais, 185 miles, in 3 hours and 20 minutes, with one stop at Amiens. There were actually three stops and two slow-downs for bridge repairs, and yet the speed from start to finish was 56 miles per hour, with a train weighing 216 tons. The run did not tax the engine in the least and the gauge glass was only twice less than half full. This is a very light engine for such work and I am told that trains of 350 to 390 tons are regularly handled on this schedule. I never saw an engine so skillfully handled and this is most interesting because of the fact that the engineer had the throttle, the variable exhaust and the independent valve gears for high and low pressure cylinders, which he could adjust at will to meet changing conditions of track and grades. He did not change them continually, but when running on a level he would indicate with his hand that we were approaching a grade and with a piece of chalk would indicate its rate and length. Before reaching the grade the ratio of expansion would be changed by the reversing wheel and except on the steepest grades the speed was apparently very nearly constant. The near approach to constant speed was necessary because of a statutory limit of maximum speed to 75 miles per hour. This fact makes these French runs specially interesting because there are no bursts of speed or spurts. Business began on leaving the terminal and it ended at the other terminal. On down grades the throttle was generally closed. Most of the way with this train the cutoffs were 40 per cent. in the high pressure and 60 per cent. in the low pressure cylinder. Up hill these were changed sometimes to 48-60 and sometimes to 48-62 and the throttle was wide open. On reaching level track again the throttle was partly closed and the ratio made 40-60. The engineer kept close watch of the gauge showing the receiver pressure and kept it usually at about 3 kilograms. But for my misfortune in not understanding the language this very

intelligent man would have made clear his reasons for everything he did. I can only say that having the facilities at his command he adjusted this compound to its work and was in position to get out of it all that the boiler could supply. In order to show the effect of the variable exhaust he purposely let the boiler pressure fall to about 200 lbs. and then turned up the cone in the exhaust nozzle by the hand wheel in the cab. In less than a minute the safety valves were blowing at 213 lbs. while the engine was working hard. This, however, slowed the engine down perceptibly until the nozzle was opened again to its running position, which was nearly wide open. The engineer shrugged his shoulders, pointed to the coal pile and very quickly opened the nozzle. Whether all of the engineers do so or not I am unable to say, but this one certainly used the nozzle, the throttle and the reversing wheel most effectively. I am told that the Northern Railway has in its employ a "compound trainer" to whose efforts among the engineers the fine character of firing and running is due.

Mentioning the variable exhaust reminds me that Mr. Koechlin showed me the detail drawings of this device. The main casting of the exhaust pipe terminates in a conical opening of 200 sq. millimeters area. Inside this is a hollow truncated cone which may be raised into this nozzle or lowered away from it into the large cavity of the pipe below. When lowered it does not interfere with the opening and when raised into the top of the pipe the inside opening of the movable cone becomes the exhaust area, which is 99 sq. millimeters. The exhaust was soft and it did not "cut" the fire except when the nozzle was made smaller purposely.

It should be stated that there is no anxiety about the lubrication of these engines. The driving boxes are oiled from the cab, while the valves and cylinders are supplied by a positive lubricating pump driven by a connection to the valve motion. This pump is placed on the running board on the left (or engineer's side), where it does its work very effectively. These pumps are being generally introduced on the Continent and I saw very few displacement lubricators. From the pump small copper pipes lead to the valves, to the cylinders and in some cases to the piston rods.

These engines have Serve tubes and by watching the vacuum gauge I could not see the slightest change in the vacuum in the smoke box when the fire door was open. The tubes were all tight, which must be attributed to the long brick arch.

We would consider the firing rather heavy. It varied from 3 to 7 scoops of coal at 4 to 6 minute intervals. Most of the coal was put rather close to the door with an occasional scoopful into the front corners. Very little of it was thrown under the arch. At intervals of about 20 minutes the fire was raked forward with a double hook. When working steam there was no smoke worth mentioning and in returning at night there were but very few sparks. The coal was coked at the back end of the firebox and was worked forward by the hook, aided by the sharp slope of the grates. The grates were of the fixed type and could not be rocked. At the front end a clinker drop afforded an opening for cleaning the fire.

These engines are supplied with briquettes in the proportion of 14 per cent. to 86 per cent. of coal. They measure 7½ by 11½ by 5½ ins. and 8 of them were kept on the deck in front of the firedoor. Several times on the run these were fired when running down grade to get the benefit of the best fuel when taking an up grade beyond. It was evident throughout the run that the engineer and firemen were personally interested in the pile of coal on the tender and they used it as if it was their own. This was a new experience for me. It did not seem to be done for the benefit of the newspaper man, but had the appearance of usual practice. I also noted that the fireman watched the engineer very closely and usually waited for a motion of his hand before putting in a fire or using the hook.

The game of running this locomotive was skilfully played. This work impressed the writer as would a violin in the hands of an artist. This engineer had more strings to his instrument than those handling other types of locomotives. He did not appear to be of higher grade of intelligence than the locomotive runners of other countries, but he had a good machine, was well trained and was truly interested in his work.

Returning from Calais to Paris this engine was put on a special train chartered to haul the crews of a couple of war vessels bought in Italy by the Japanese government and destined for use in the war with Russia. The crews appeared to be very Irish. They were certainly very drunk and proved to be a heavy load. The train weighed but 178 tons, but the coal was bad and signal stops were frequent and vexatious. I was glad to have the opportunity to see the engine get out of its difficulties. In spite of 6 stops and 15 minutes of dead time, the run of 185 miles was made at 50 miles per hour from start to finish. Once on the run, while both injectors were feeding, one of them broke and before it was started going again the steam ran down to 12 kilograms. The fireman did his best, but could not get it back. The engineer took the scoop and in about fifteen minutes had the full boiler pressure of 16 kilograms again by his firing alone. I raised my hat to him and pointed to the gauge. He chuckled; went back to his side of the cab again and smiled all the way back to Paris.

These cabs are of little use. The wind blows through them as through a Dakota barn and makes them supremely uncomfortable. I could not light my cigar even down among the oil cans until the engineer came to my aid with a bit of waste which he had touched against the inside of the firedoor. Ugh! I cannot understand why these people do not put respectable cabs on their engines. It seems that the enginemen themselves object to American cabs, but it is incomprehensible that they do not wish to be better protected, for often the weather is cold, as it was that day.

The running skill of this engineer tells of years of definite and conscientious effort on the part of the whole department of which Mr. du Bousquet is the head. It tells of a system of operating the department which has been years in growing. It offers most favorable evidence of the value of cash premiums and constitutes practice which we may study with advantage. Above all other things it shows that the machinery is but a part of the whole and that the training, the encouragement and the interest of the men operating it is an all important part.

G. M. B.

(To be continued.)

THE RELATIVE STEAM ECONOMY OF BALDWIN AND DE GLEHN BALANCED COMPOUND LOCOMOTIVES.

To the Editor:

In the course of the interesting record of road tests of the Burlington & Missouri River Railroad, 4—4—2 type, Baldwin balanced compound locomotive No. 2700, which appears on page 460 of the current issue of the AMERICAN ENGINEER, the average normal water-rate of the engine is given as 22.86 lbs. per indicated h.p. per hour.

This is certainly a most admirable performance, which reflects great credit upon the designers and builders of the locomotive, and also upon the motive power officials responsible for its maintenance and operation.

For the purpose of comparing this water-rate with that of recent examples of the Du Bousquet-deGlehn type of compound locomotive on the Paris-Orleans Railway, the following remarks made by M. Edouard Sauvage, chief consulting engineer Western Railway of France, at the April, 1904, meeting of the Institution of Mechanical Engineers, are of special interest:

M. Sauvage said that "a long series of experiments, made on the Paris-Orleans line with trains of different weights, had shown a steam-consumption per h.p. per hour never differing much from 23 lbs. The h.p. was neither the indicated h.p. nor the power calculated from the draw-bar pull; but it was the h.p. exerted by the wheel on the rail, and that power was calculated from the results of numerous experiments made with the use of the dynamometer car. The Paris-Orleans Railway engineers were confident that they could calculate carefully and closely the effective pull exerted by the wheel on the rail, and that was what they called an effective h.p. They found that with trains of 220 tons (2,240 lbs.) the average steam consumption was 23 lbs. With trains of 260 tons it was 22.6 lbs. With heavy trains of 352 tons it was 23.7

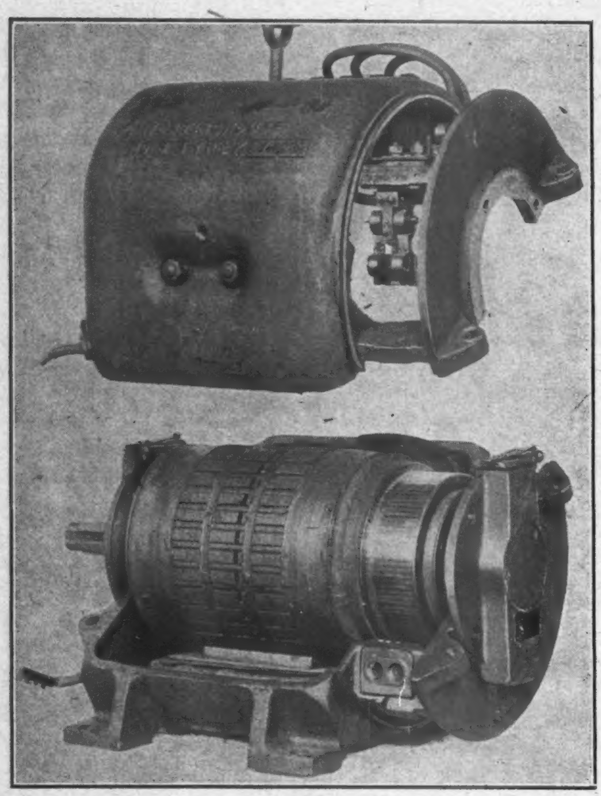
lbs. There was, therefore, hardly any difference in the water consumption per effective h.p. per hour in all these different cases. When one came to practical work it would be seen that heavy train working was more economical than light train working. It was most definitely so, because the weight of the engine was a smaller proportion of the weight of the whole train." (Proceedings Inst. Mech. Engrs., 1904, page 451.)

Since the steam consumption of the Baldwin locomotive is based upon the indicated h.p., while that of the Paris-Orleans engines is stated in terms of the effective h.p. at the periphery of the driving wheels, it is obviously impossible to make an accurate comparison between the economy of the two designs of locomotives; but it is nevertheless apparent that although the mean water-rate of the American engine is higher than that of its formidable French rivals, the smallness of the disparity demonstrates that the former is an exceedingly economical locomotive.

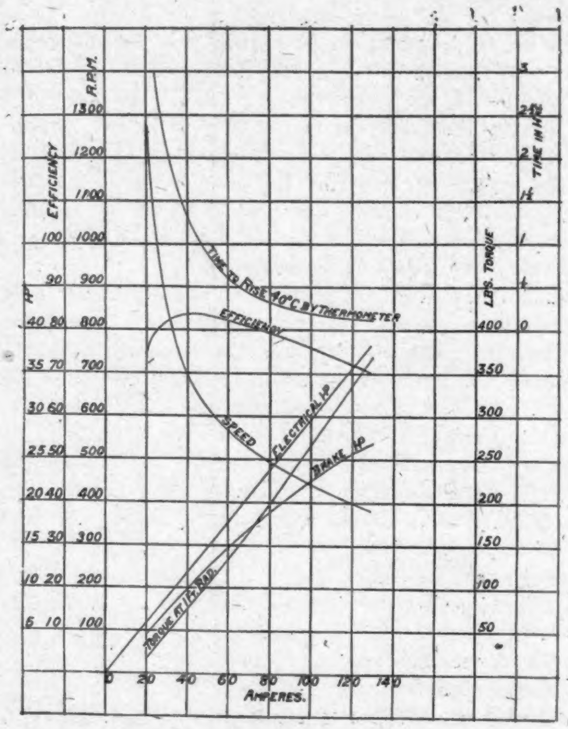
EDWARD L. COSTER,
25 Broad street, New York. Assoc. Am. Soc. M. E.
December 6, 1904.

SATISFACTORY SUBURBAN SERVICE.—In a paper read before the International Railway Congress, Mr. A. W. Sullivan states that the cars designed by him for the Chicago suburban service of the Illinois Central Railroad have shown the possibility of discharging 100 passengers in 4 seconds at the terminal station, and that stops at intermediate stations, where many passengers enter and leave the cars, are reduced from 6 to 8 seconds. These cars were illustrated in this journal in 1903, and have met the expectations of the designers in every particular.

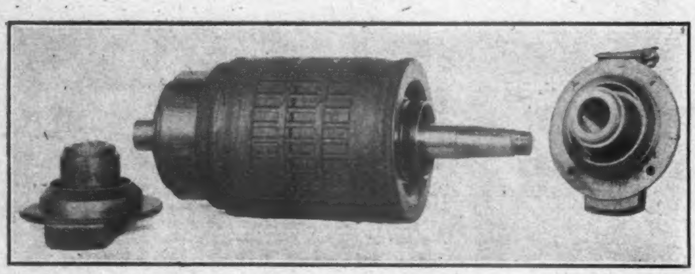
LONG LOCOMOTIVE RUN.—The Great Central Railway (England) ran a special train, October 28, making the entire run of 300 miles between Manchester and Plymouth, with one engine. The same engine immediately made the return journey. This had never been attempted before in Great Britain.



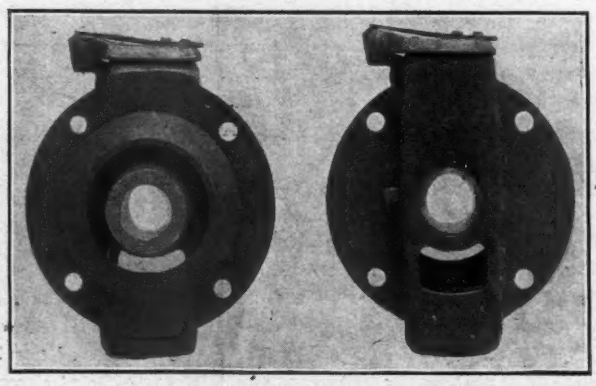
WESTINGHOUSE TYPE K CRANE MOTOR WITH UPPER FIELD RAISED.



EFFICIENCY CURVE—WESTINGHOUSE NO. 6 TYPE K CRANE MOTOR.



ARMATURE AND BEARING HOUSINGS—WESTINGHOUSE TYPE K CRANE MOTOR.



BEARINGS AND BEARING HOUSINGS—WESTINGHOUSE TYPE K CRANE MOTOR.

NEW WESTINGHOUSE CRANE MOTOR.

The service required of an electric crane is very exacting, and it is important that the motor be selected with the greatest care, as its failure may seriously incommode the plant in which it is used and cause heavy losses, due to restricted output. Westinghouse type K motors are designed for the operation of cranes, hoists and similar apparatus, and for intermittent service, in which heavy starting torques and wide speed variation are required. They are strong and compact, convenient to install, adaptable to every practical form of mounting, and are reliable, economical and powerful in operation.

The frames are of the wholly enclosed form, to guard against dirt and moisture, but are so designed that the working parts may be exposed for inspection or adjustment without dismantling. These motors have four inwardly projecting poles,

each of which is magnetized by a separate field coil, which arrangement is claimed to be very advantageous. They are series wound, and are designed for operation on direct current circuits of 220 and 500 volts. Since the current passes successively through the armature and field winding, the torque of such a motor increases nearly as the square of the current up to the point of saturation of the iron. For this reason the series motor is particularly well suited to the starting and acceleration of heavy loads. Governed by change of voltage at the motor terminals, the speed of the motor is carried through a wide range.

The motor frames are of cast steel, except in the three smallest sizes, and are extremely compact. The frame is built in two parts, divided in a plane passing through the axis of the armature and at an angle of 34 deg. with the horizontal, an arrangement which allows the upper half of the field to be removed without disturbing the gears or shaft, and makes it easy to take out a pole piece and field coils, or to remove the armature. The commutator end of the frame is connected to the poles by six ribs, any two of which may carry the brush holders. The opening around the commutator is entirely closed by a 3-32-in. sheet steel band, fastened by thumb screws, an arrangement which permits access to the commutator and brush holders at all points. The four pole pieces are built up of soft steel punchings, riveted together between wrought iron end plates, and are secured to the frame by bolts which pass well into the punchings, but leave the pole face smooth and unbroken. The coils of the larger motors are of copper strap, and the terminals are insulated with asbestos ribbons. They are fitted to the pole pieces, protected at the ends by oiled duck, and held in place by the spreading tips of the pole pieces. Large journal bearings are provided, which consist of shells lined with bronze or babbitt, and mounted in housings which may be removed without separating the motor frame.

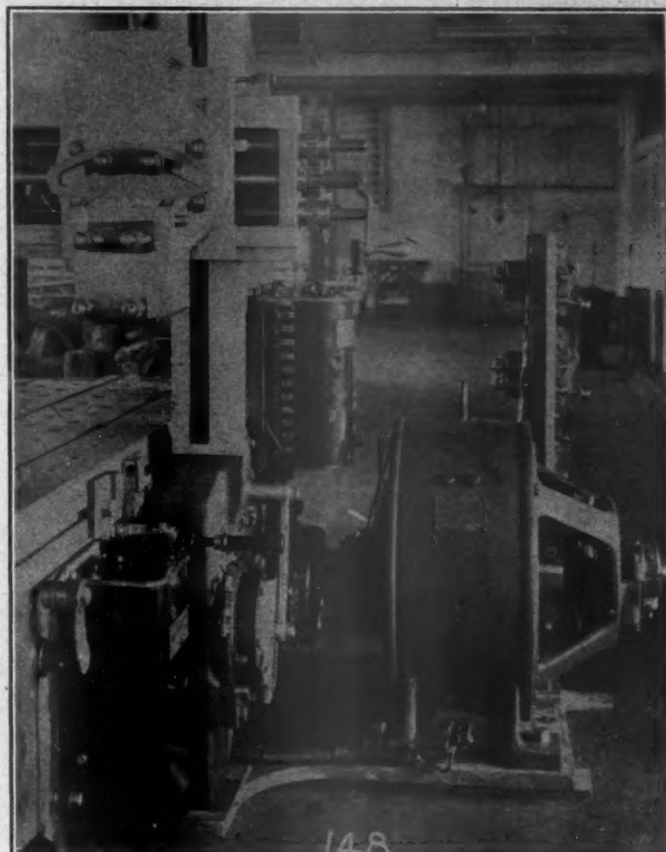
The armature core is built up of soft steel punchings of high permeability, carefully annealed by a special process. The pinion end is provided with a bell-shaped flange, which forms a support and shield for the armature coils. Ducts between the punchings are provided through which air, drawn in through openings in the spider, is forced out against field coils and core, maintaining a uniform temperature throughout all parts of the motor. The commutator is mounted on the armature web, allowing the shaft to be removed without disturbing the winding or connections.

The commutator is built up of bars of hard drawn copper, insulated by prepared mica, and mounted on the armature spider. The brush holders are of the sliding type, and possess many features of peculiar merit. Adjustment can be made to compensate for wear of the commutator. With all but the two smaller sizes a shunt is connected to the tip of the spring, extended back over the spring and securely fastened to the brush holder, thus relieving the spring of the duty of carrying current, insuring good contact, low operating temperature and a permanent and even tension. With every carbon brush ⅝ in. or more in thickness, an additional sheet is provided connecting the carbon itself to the carbon holder, improving the contact between carbon and holder, and preventing that pitting of the brush which is so annoying and troublesome, besides offering a further protection to the temper of the spring.

IMPROVED MOTOR DRIVE FOR PLANERS.

Among the many improvements which we have recorded in planer drives during the past few years, none have been so radical as that of connecting an electric motor direct to the cross-shaft of the planer, and reversing the motor at each end of the stroke. It seems almost incredible that the armature of a high-speed motor can be stopped and reversed without a considerable loss of time; but, as a matter of fact, it stops, reverses, and accelerates so quickly, that the planer platen seems to travel at a constant speed to the end of the stroke, stop quickly, and then accelerate so fast on the return stroke that it is at full speed before it has moved more than 3 or 4 ins. Not only this, but if one of the motor commutator bars is marked, it will be seen to stop at exactly the same place at each stroke. The device does not require a special type of motor, and it can be arranged to provide a number of different cutting speeds, with a constant speed for the return stroke.

The advantages of such a drive are that the belts, pulleys and shifting mechanism can be done away with, thus greatly simplifying the drive; the speed of the platen on the cutting stroke, which is ordinarily limited, because of the belts can be increased, and the advantages of the high-speed tool steels can be more fully realized. The Electric Controller & Supply Company, of Cleveland, have had this drive running successfully for some time on a 36-in. and a 96-in. planer at the works of Wellman-Seaver-Morgan Company in Cleveland, and also on



APPLICATION OF IMPROVED MOTOR DRIVE TO PLANER—ELECTRIC CONTROLLER & SUPPLY COMPANY.

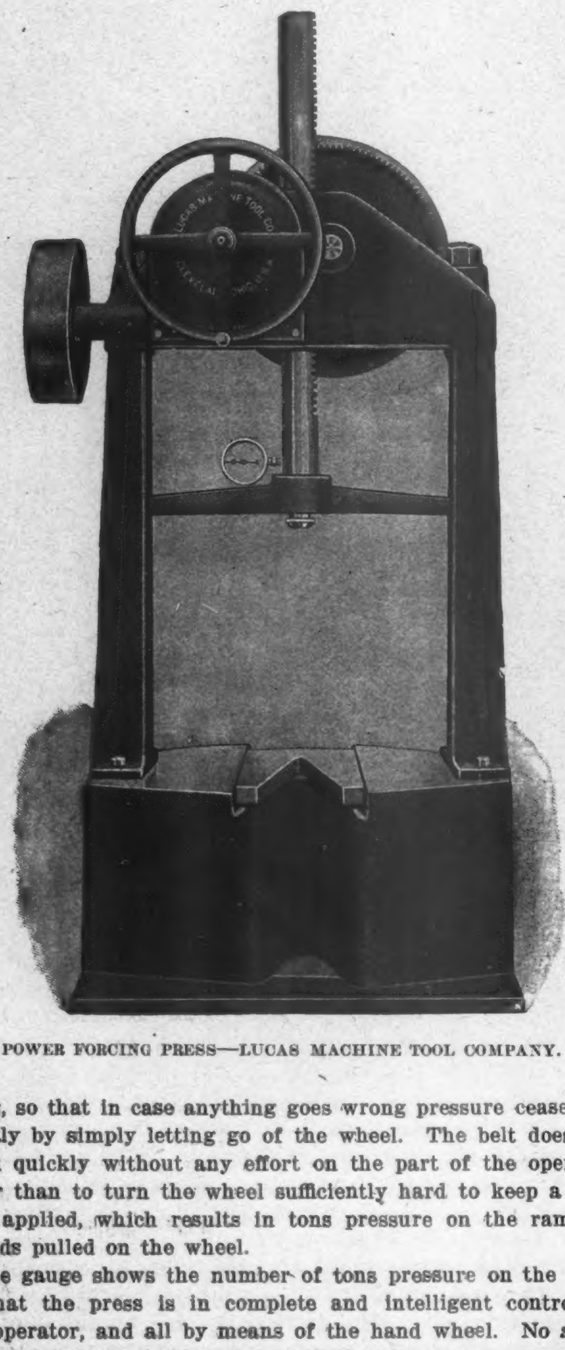
a 36-in. Pond planer, which was exhibited at the St. Louis Exposition.

The photograph shows the arrangement of the electrical apparatus. The motion of the motor is reversed by means of a magnetically operated controller, carried on the switchboard shown just beyond the motor. The operation of this controller is such that a platen will reverse and accelerate just as rapidly as is consistent with the power of the motor. The maximum current which can flow to the motor is absolutely limited, so that there is no sparking or undue mechanical straining at the instant of reversal. On future installations this controller will be moved closer to the planer bed, where it will be out of the way of passing workmen. In addition to the magnetic switch controller, the equipment consists of a reversing switch, mounted on the bed of the planer, and which may be operated either by the adjustable dogs on the platen or by a lever. This lever is the only apparatus necessary to start or stop the planer, and can be thrown either on or off as quickly as desired, without danger of injuring either the motor or machine. The field rheostat, or operating controller, on the side of the housing is used for varying the speed of the cutting stroke of the platen. This controller is provided with a notched dial, which plainly shows the cutting speed for each step.

POWER FORCING PRESS.

The simple and convenient power forcing press illustrated in the photograph is designed to do rapidly all kinds of work requiring pressure, much of which has heretofore been done by sledges or slow-moving hand presses.

The uses of such a press are practically universal and include such work as forcing arbors, bushings and pins in or out of holes, straightening shafting, forming, broaching, all kinds of testing work, and will be found especially convenient in railroad shops for forcing in or out rod and driving box brasses. Pressure is applied by the large hand wheel, which quickly raises or lowers the ram until it meets with resistance, when power is automatically applied, the pressure being proportionate to the turning force applied by the operator. As soon as this force is released the action of the press



POWER FORCING PRESS—LUCAS MACHINE TOOL COMPANY.

stops, so that in case anything goes wrong pressure ceases instantly by simply letting go of the wheel. The belt does the work quickly without any effort on the part of the operator other than to turn the wheel sufficiently hard to keep a friction applied, which results in tons pressure on the ram for pounds pulled on the wheel.

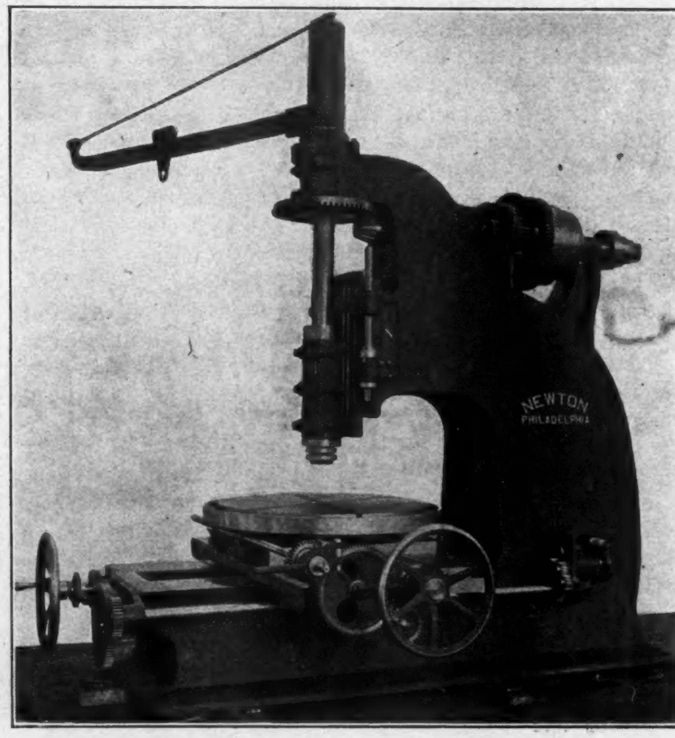
The gauge shows the number of tons pressure on the ram, so that the press is in complete and intelligent control of the operator, and all by means of the hand wheel. No shifting of belts or clutches is required; there are no pumps, packing or valves to keep in order and there is nothing to freeze.

These presses are made by the Lucas Machine Tool Company of Cleveland in two standard sizes of 15 and 30 tons capacity. Presses adapted for higher pressures and in horizontal or special forms may be made to order.

VERTICAL MILLING MACHINE.

The photograph illustrates a large vertical milling machine recently installed in the Havelock shops of the Burlington & Missouri River Railroad. Although it has been in use but a short time, it has greatly reduced the cost of a number of operations which were formerly done on slotting machines. These include the machining of dome saddles, side rod ends, mud rings, cab brackets, equalizers, front frames and braces, cross braces, cinder hopper bases, reverse lever quadrants, links and cast-iron pedestal jaws for engine and tender trucks.

The machine is very heavy and powerful, and was designed for the use of high-speed tool steels. The spindle, which is 5 ins. in diameter, is driven by the three-step cone and the bevel gears; the cone is back geared, thus furnishing six changes of speed. The circular table is 48 ins. in diameter over the tee slots and 54 ins. over all, and has a cross adjustment of 36 ins. The table has five changes of automatic feed in either a rotary, cross or longitudinal direction, each motion being controlled by clutches conveniently placed; the



VERTICAL MILLING MACHINE—NEWTON MACHINE TOOL WORKS.

reverse motion is imparted by the tumble gears shown in the illustration. The distance from the top of the table to the under side of the throat is 20 ins., and from the center of the spindle to the frame is 28 ins. The auxiliary self-contained crane is used for supporting the end of long overhanging work. The machine was made by the Newton Machine Tool Works of Philadelphia, and they are now arranging to fit the spindles of this type of machine with vertical automatic feed.

FIVE AND ONE-HALF MONTHS CONTINUOUS RUN.—The 600-h.p. Westinghouse steam turbine generating unit which supplied current for light and power throughout the Westinghouse exhibits at the St. Louis Exposition, was shut down on December 2 after a continuous run of five and one-half months, or 3,962 hours. The remarkable feature of the run was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8.30 o'clock in the morning to 10.30 o'clock in the evening, the load carried throughout the exposition varied from 25 per cent. underload to 25 per cent. overload. The total number of revolutions almost touched the billion mark—855,792,000. It was found to be in perfect condition, with no signs of wear, the bearings still retaining the tool marks as they had come from the shop.

IMPROVED VALVES.

After 50 years of practical experience in the manufacture of steam appliances, the Crane Company, of Chicago, has developed a number of improvement of importance to those having to do with locomotives and the application of steam for power and heating. This company has brought out improved globe and angle valves with renewable seats and discs. They are suitable for working pressure up to 250 lbs. per sq. in., and are tested to pressures as high as 700 lbs. The renewable parts are made of hard composition, specially developed by these manufacturers for severe service. Fig. 1 shows the construction of a straight valve. By unscrewing the nut on the bottom of the valve all parts are accessible and removable from the top, making it convenient to substitute a new seat

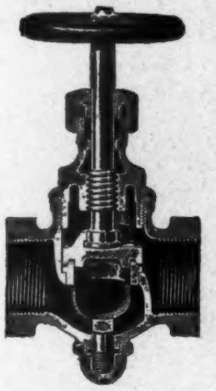


FIG. 1.

FIG. 2.

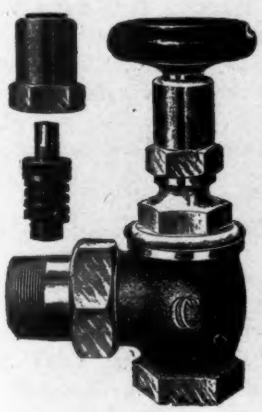


FIG. 3.

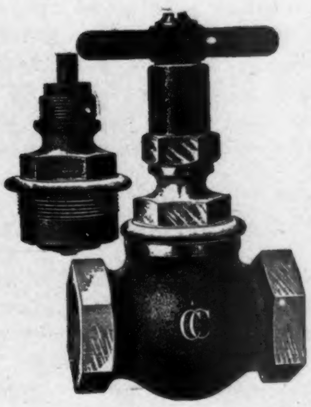


FIG. 4.

or disk and to replace any worn part. Being attached to the stem by a slot, the disc is easily removed and replaced. The disc and seat may be removed and ground together if necessary. When putting the valve together the seat is replaced and the nut on the bottom of the valve tightened up to hold the seat in place. The bonnet is then screwed on and the valve closed. These valves may be packed without steam escaping; to do this the valve is opened wide.

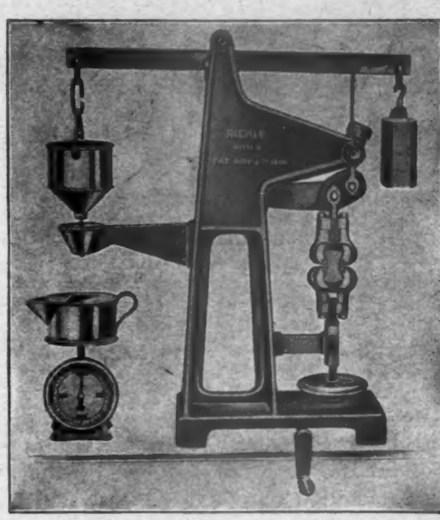
The Crane straightway valves with renewable seat and wedges are made with copper seats and hard metal wedges. They are suitable for working pressure of 250 lbs., and are tested to 800 lbs. Fig. 2 illustrates an easy method of inserting these renewable parts in these valves. Soft metal rings or seats are furnished, for air or water in these valves.

Figs. 3 and 4 illustrate self-packing radiator valves, employing Jenkins discs and non-rising stems. Leaky stuffing boxes are avoided by the use of rubber pieces between the metallic parts, which ordinarily grind together and become leaky. This vulcanized rubber prevents leakage and may be renewed when it becomes worn. The bonnet threads of these self-packing valves are the same as those of the Jenkins disc valve made by the Crane Company, and the self-packing device is also applicable to the Crane brass wedge gate valves with non-rising stems.

RIEHLE U. S. STANDARD AUTOMATIC CEMENT TESTER.

This illustration shows the Riehle U. S. Standard 1,000 lbs. (500 kilos) automatic cement tester. It is constructed entirely of metal, and is of superior design and finish.

The beam is brought to a balance by pouring shot into the cone shaped bucket on the left, thus counterbalancing the weight on the right hand side. The test briquette is then placed in the grips and by means of the handwheel under the lower grip the slack is taken up. A piston valve in the bucket is then lifted and the shot flows out of the bucket, causing the weight to overbalance the bucket and load thus to be applied to the specimen. When a sufficient weight of shot has flowed out of the bucket, the unbalanced force of the weight is sufficient to break the briquette, and then the lightened bucket is jerked by the weight and the piston valve in it closed, causing the flow of shot to cease. The weight of shot which has flowed out is a measure of the force required to break the briquette, and this shot is caught in a scoop on a scale which is graduated to read directly the stress on the briquette. If at any time the briquette should be so yielding as to allow the beam to strike the lower buffer before the



NEW RIEHLE CEMENT TESTER.

briquette is broken, the valve automatically closes and the flow of shot ceases. Then, if desired, the beam can be raised by means of the worm and wheel and the test continued. The piston valve (patent Nov. 8, 1904) for controlling the flow of shot is believed to be the simplest and most effective automatic valve made. If it is desired to make a test of extreme accuracy the beam may be kept horizontal during the test by means of the crank and worm wheel.

This description and operation applies to both sizes of cement testers. The weight of shot in the 1,000-lb. machine is as 1 to 100 lbs.; this means that 10 lbs. of shot on an ordinary scale would indicate a strain of 1,000 lbs. In the 2,000-lb. machine the proportion is 1 lb. to 80 lbs., viz., 25 lbs. of shot will indicate 2,000 lbs. strain.

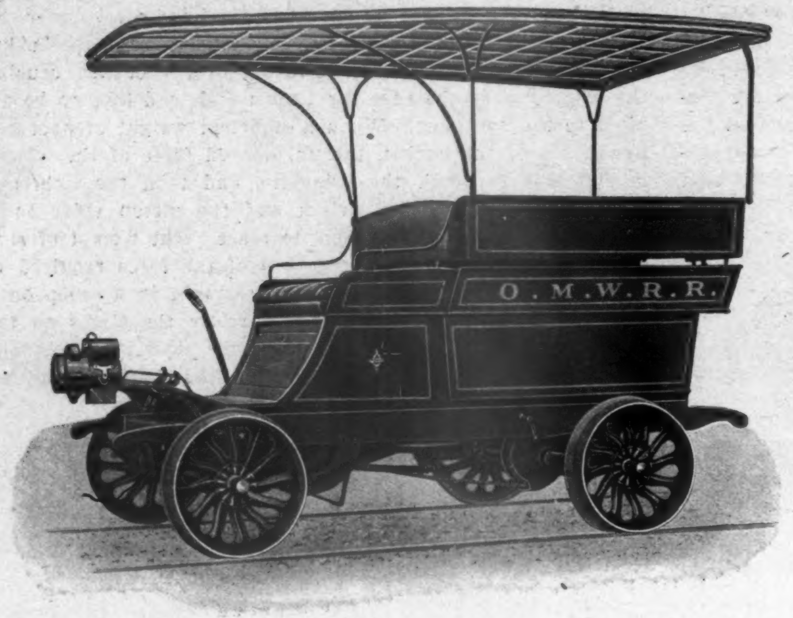
These machines have been placed on the market after proving themselves in exhaustive tests, which is characteristic of the methods of this firm. The name by which they are known is "Bestone," and the 1,000-lb. size is adapted to most general use among engineers.

Mr. C. S. Larrison has been appointed master mechanic of the Dakota division of the Northern Pacific Railway, with headquarters at Jamestown, N. D., to succeed Mr. J. E. O'Brien, promoted. Mr. Larrison was formerly general airbrake inspector of this road.

Mr. T. A. Lawes, who recently resigned as superintendent of motive power of the Chicago & Eastern Illinois, has been appointed mechanical engineer of the New York, Chicago & St. Louis Railroad, with headquarters at Cleveland, O., to succeed Mr. J. T. Carroll.

OLDSMOBILE INSPECTION CAR.

This illustration shows a new type of inspection car, known as Model No. 2, tonneau car. It is, in general, similar to the Oldsmobile railroad inspection car No. 1, except that it has a tonneau added, giving a capacity of eight passengers. The tonneau may be removed and replaced by a platform, to carry men and tools for ordinary repair work. This car is driven by a 7-h.p. gasoline engine, giving a speed of 35 miles per hour, which is variable and under control, the engine and gearing being the same as that used in the Oldsmobile runabout. The car is built for standard gauge. It has a 62-in. wheelbase, oak sills, 20-in. pressed steel wheels, cold rolled axles and powerful brakes. Its capacity for water and gasoline is sufficient for 100 miles. These cars are reported to have run 3,000 miles over a road having 3 per cent. grades. It is sold by the Railway Appliances Company, Old Colony Building, Chicago.

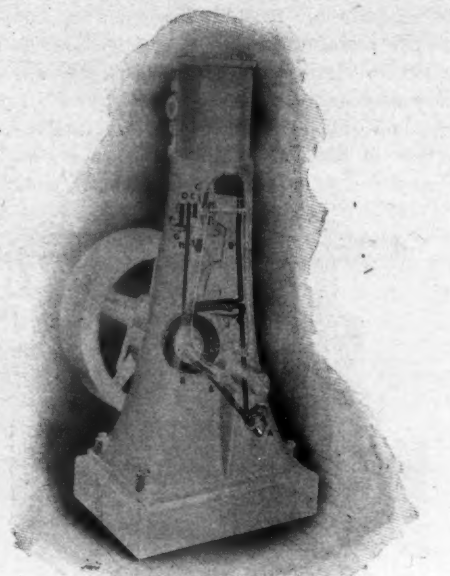


OLDSMOBILE INSPECTION CAR.

AN IMPROVED SMALL VERTICAL ENGINE.

A new design of small upright engine, in which special attention has been given to the oiling system, has been placed on the market by the American Blower Company, of Detroit, Mich. It has been developed specially for continuous service, such as driving dynamos, pumps and blowers.

The working parts are entirely enclosed, as indicated in the phantom engraving. Oil is delivered to the bearings in streams. From an oil pump, A, the plunger, L, which is driven by an eccentric, K, on the shaft, forces the oil up through the tube, B, into the strainer, C, from which it drops into an oil box and passes through four tubes to the guides and bearings. Two of these tubes, F and G, take oil to the guides. Tube E supplies the crosshead pin, the oil dropping into the cup H. The oil dropping from the crosshead is caught in two pans attached to the inside of the covers. From these it runs down the inside of the cover, dropping into a cup in the top of the main bearing cap. Instead of using oil grooves at the top and bottom of the main bearing, as customary, in this system the bearing is cut away at the joint so that the oil is carried to the bottom of the bearing when the connecting rod thrust is upward, but when the load is reversed there are no grooves to carry away this oil. Tube D oils the crank pin and discharges into a crank oil ring inside of the eccentric, K, which in turn discharges into the crank pin oil tube and takes the oil across the crank pin bearing. By this independent supply the crank pin oil ring catches the drip from one end of the main bearing, the eccentric being oiled by the drip which it catches from the other end. No difficulty has been experienced in catching the oil thrown off of the eccentric strap and the splash from the crosshead has been equally easy to take care of, the outside of the engine being entirely free from oil. The large base affords a good opportunity to cool and settle the oil; a portion of it as it drops back into the bottom of the frame drops into an oil filter. This engine was subject to severe test and experiment for two years before being placed upon the market. It is stated that one of the engines was adjusted and filled with oil on March 10; up to July 15 no adjustment of any kind had been made, and no oil added except to fill the sight feed cylinder lubricator. The engine runs from 14 to 16 hours a day, driving a blower, and for four months ran almost as noiselessly as at first.

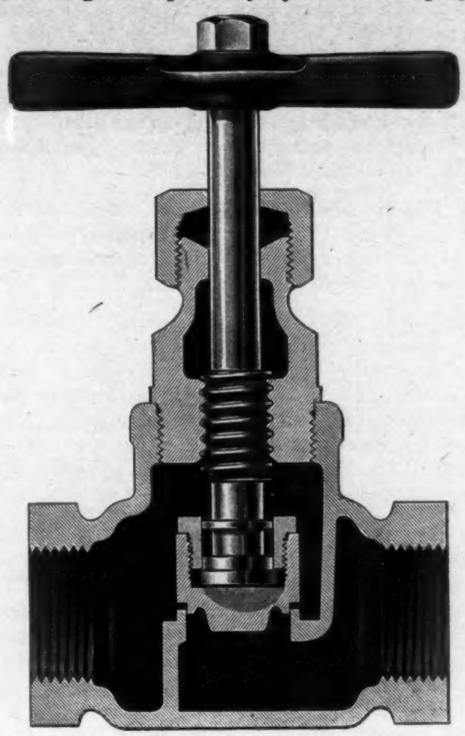


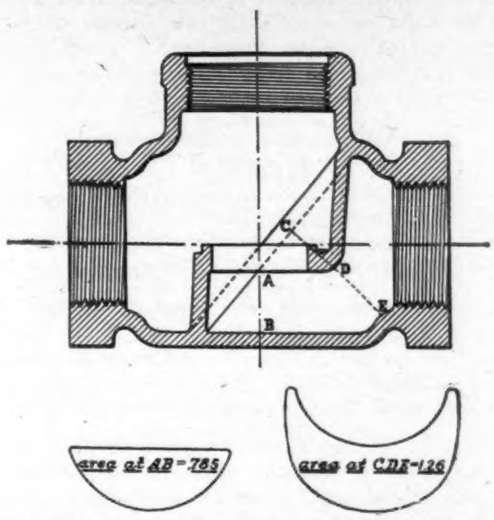
IMPROVED SMALL VERTICAL ENGINE.

HANCOCK VALVES.

These valves are made of special composition to secure strength and good wearing qualities. They are made in one standard only for all pressures. The manufacturers guarantee that every globe, angle, 60-deg. and cross valve has been tested with 1,000 lbs. pressure and found tight before leaving the works. They are guaranteed for 500 lbs. steam pressure. The bodies are made of hard and tough mixture to secure durable valve seats. The discs are of a special mixture which does not include zinc. Tobin bronze is used for the spindles. These valves are similar in design to the Hancock main steam valves used for a number of years on locomotives. The sectional sketch shows the areas of the most contracted parts of a 1-in. globe valve. The metal is distributed to give uniform strength, and the areas have not been reduced or contracted for the purpose of reducing weight. One of the sectional engravings shows two collars on the stem guiding the valve for the purpose of seating it squarely, to prevent the disc from cocking. The valve seat is flat, and is provided with a projection, which acts as a guide in the grinding and prevents the cutting of the seat by the wire-drawing of the steam when the valve is opened slightly. When the valve is slightly raised, as shown in the section, the escaping steam cleans the seat of dirt. The makers state that very little regrinding is required to restore tightness after the valve begins to leak. These valves have long threads in the bonnets, and by means of a narrow seat on the shoulder it is possible to keep the bonnet tight, and yet it is easy to unscrew it. This is considered a positive improvement over bonnets having wide shoulders bearing upon wide surfaces upon the top of the valve body. To regrind a valve to its seat, the bonnet is removed, the disc nut unscrewed from

the disc, and a piece of wood may be inserted in the disc, permitting it to be ground perfectly by aid of the projection on





the disc which guides it, thus avoiding the necessity for special regrinding tools. These valves have tee handles, the hole in the handle is tapered, with one side flat, and the handle is held to the spindle by means of a nut. The flattened side holds the handle rigidly in place, while the taper permits it to be drawn tightly to the spindle to avoid the annoyance of loose handles.

These valves are made by the Hancock Inspirator Company, 85 Liberty street, New York.

PERSONALS.

Mr. Thomas Jackson has been appointed shop superintendent of the Northern Pacific Railway at Livingston, Mont.

Mr. M. J. McGraw, master mechanic of the Illinois Central, has been transferred from East St. Louis to Clinton, Ill.

Mr. E. C. Walker has been appointed foreman of the car department of the Houston & Texas Central at Spencer, Texas.

Mr. H. J. Uhlenbrock has been appointed assistant master mechanic of the Wabash Railroad, with headquarters at Decatur, Ill.

Mr. J. J. Shaw has been appointed division foreman of the St. Louis & San Francisco at Neodosha, Kansas, succeeding Mr. C. E. Brown.

M. J. H. Nash has been appointed master mechanic of the Illinois Central at East St. Louis, Ill., to succeed Mr. M. J. McGraw, transferred.

Mr. W. J. Schlacks, master mechanic of the Colorado Midland, has been appointed superintendent of motive power, to succeed Mr. J. R. Groves.

Mr. Gustav Navarro has been appointed superintendent of motive power and machinery of the Vera Cruz & Pacific Railway at Tierra Blanca, Mexico.

Mr. A. H. Powell has been appointed master mechanic of the Chicago & Eastern Illinois Railroad at Villa Grove, Ill., to succeed Mr. J. W. Bell, resigned.

Mr. R. H. Rutherford has been appointed assistant master mechanic of the Mexico Division of the Mexican Central Railway with office at Aguascalientes.

Mr. John W. Bell, master mechanic of the Chicago & Eastern Illinois, has been transferred from Oak Lawn to Villa Grove, Ill., to succeed Mr. A. H. Powell, resigned.

Mr. J. E. Chisholm has been appointed master mechanic of the Oelwein shops of the Chicago Great Western Railway at Oelwein, Ia., to succeed Mr. R. M. Crosby.

Mr. J. M. Markey has been appointed master mechanic of the Northern Division of the Grand Trunk, with headquarters at Allendale, Ont., succeeding Mr. N. B. Whitsel.

Mr. H. O. Bowen has been appointed master car builder of the Missouri, Kansas & Texas Railroad, with headquarters at Sedalia, Mo., to succeed Mr. J. L. Wigton, resigned.

Mr. G. H. Bussing has been appointed superintendent of motive power of the Evansville & Terre Haute Railroad, with headquarters at Evansville, Ind., succeeding Mr. W. J. M. Leish.

Mr. J. Montgomery has been appointed master mechanic of the Northern Division of the Grand Trunk Railway, with headquarters at Allendale, Ont., to succeed Mr. N. B. Whitsel, resigned.

Mr. C. H. Burk, master mechanic of the Mexican Central Railway, is transferred from Aguascalientes to Mexico City, where he will succeed to the duties of Mr. G. W. Jennings, resigned.

Mr. E. W. Fitt has been appointed assistant superintendent of motive power of the Burlington & Missouri River Railroad, with headquarters at Lincoln, Neb. He is promoted from the position of chief draftsman.

Mr. John Whetstone has been appointed superintendent of motive power of the Norfolk & Southern Railway, with headquarters at Berkley, Va. His title has heretofore been acting superintendent of motive power.

Mr. J. E. O'Brien has been appointed assistant shop superintendent of the Northern Pacific Railway, in charge of the shops at South Tacoma. He is promoted from the position of master mechanic of the Dakota division.

Mr. Charles H. Quereau has been appointed engineer of tests of the New York Central & Hudson River Railroad, with headquarters at Albany, N. Y. For the past two years Mr. Quereau has been superintendent of shops at West Albany.

Mr. J. T. Carroll has resigned as mechanical engineer of the New York, Chicago & St. Louis Railroad, to accept the position of chief draftsman of the motive power department of the Lake Shore & Michigan Southern at Cleveland, O.

Mr. R. P. Blake has been appointed assistant shop superintendent of the Northern Pacific Railway at Brainerd, Minn., in charge of the shops at that point. He has heretofore served the road in the capacity of mechanical engineer at St. Paul.

Mr. J. R. Groves has been appointed superintendent of the motive power and car departments of the Denver & Rio Grande Western Railways, with office at Burnham, Col., succeeding Mr. F. Mertsheimer, resigned. Mr. Groves resigns as superintendent of machinery of the Colorado Midland to accept this office.

Mr. E. E. Davis has been appointed superintendent of motive power of the Buffalo, Rochester & Pittsburg Railroad, with headquarters at DuBois, Pa., to succeed Mr. F. T. Hyndman. Mr. Davis has been connected with the motive power departments of the Boston & Maine, the Philadelphia & Reading, and the New York Central & Hudson River railroads.

NEW CATALOGUES.

IN WRITING FOR THESE CATALOGUES PLEASE MENTION THIS PAPER.

ADJUSTABLE REAMER.—Bulletin from the Gisholt Machine Company of Madison, Wis., describing the Gisholt "Solid" adjustable reamer.

THOMPSON-RYAN DYNAMO.—Bulletin No. 14 issued by the Ridgway Dynamo & Engine Company, Ridgeway, Pa., describes in detail the construction of the Thompson-Ryan dynamo.

MACHINE TOOLS.—The Springfield Machine Tool Company, of Springfield, Ohio, are issuing a catalog which very completely describes their line of brass and iron working machinery.

GRINDERS.—Catalogue from Charles H. Besly & Company, So. Clinton st., Chicago, which describes the Gardner grinder, the Besly band grinders and the taps and dies made by the company.

A PAINT THAT PREVENTS RUST.—Circular issued by the Detroit Graphite Manufacturing Company, Detroit, Mich., concerning the use of their "Superior Graphite Paint."

VALVES.—The Hancock globe, angle, cross, 60-deg. and check valves are described in a catalogue issued by the Hancock Inspirator Company, 85 Liberty St., New York. These valves are tested and guaranteed tight under a hydraulic pressure of 1,000 pounds.

MECHANICAL STOKERS.—The Westinghouse Machine Company, East Pittsburgh, Pa., have just issued a very complete catalogue of 60 pages describing the Roney mechanical stoker and calling attention to the advantages to be gained by its use. A number of important installations are illustrated.

GRAPHITE LUBRICANTS.—A 30-page pamphlet has been received from the Joseph Dixon Crucible Company of Jersey City, N. J., devoted to the interests of their well known graphite products for lubricating purposes. This pamphlet presents the theory of this lubricant and explains the function of flake graphite.

FOUNDRY CHAPLETS.—W. W. Lindsay & Company, Harrison Building, Philadelphia, distribute a sixteen page pamphlet describing their foundry chaplets and anchors, which are extensively used by the Pennsylvania Railroad, Philadelphia & Reading, Baldwin Locomotive Works and other large users of castings from their own foundries.

PULVERIZING MACHINERY.—Catalogue No. 30 issued by the Jeffrey Manufacturing Company, Columbus, Ohio, describes the various lines of pulverizing machinery made by them. These include the crushing machinery made by Schoellhorn-Albrecht Machine Company, the patents of which have been acquired by the Jeffroy Company.

VARIABLE SPEED MOTORS.—Flyer No. 253 issued by the Crocker-Wheeler Company describes their new line of variable speed field control motors for single voltage circuits. These are intended for use where the installation of the multiple voltage system is not warranted. These motors are arranged in two classes, one adopted to give constant horse power throughout a speed range of 2 to 1, and the other through a speed range of 3 to 1.

WESTINGHOUSE TYPE S MOTORS.—Folder No. 4030 issued by the Westinghouse Electric & Manufacturing Company describes their type S motor for direct current circuits and illustrates its application to various machine tools.

GRAPHITE LUBRICATION.—The January issue of "Graphite" published by the Joseph Dixon Crucible Company of Jersey City, N. J., is a special number devoted entirely to graphite lubrication. Copies will be sent free to those interested.

COE'S WRENCHES.—Coe's Wrench Company, Worcester, Mass., has issued a four-page pamphlet illustrating and describing the ordinary screw wrench bearing this well known name. The wrenches are illustrated in a number of styles, the features of each, the different finishes and the prices being given. These have knife handles, steel handles and wooden handles; also the key model is shown. This company is prepared to send literature of their wrenches to users of these tools.

FARLOW DRAFT GEAR.—A leaflet issued by the Farlow Draft Gear Company, Monadnock building, Chicago, contains a reprint of the test on this gear from the December number of this journal, a large photographic view of the M. C. B. testing machine with the record of the M. C. B. tests of 1902 indicated upon it, and also a number of the claims made for the Farlow draft gear. Prominent among these is the absence of wrought followers, pockets, spring straps and bolts. Eleven contingencies which will take a car with an ordinary gear to the repair track are enumerated, with the claim that the Farlow gear reduces this number to two—the breakage of couplers. This gear is guaranteed for ten years against fair and unfair usage. In the photographic view referred to the record of the Farlow gear is shown as surpassing the others.

NOTES.

NORTHERN ELECTRICAL MANUFACTURING COMPANY.—The Tennessee Coal, Iron & Railroad Company, of Birmingham, Ala., have ordered three 150 k.w. Northern slow speed generators.

PHILLIP CAREY MANUFACTURING COMPANY.—This company announce they have been awarded the gold, silver and bronze medals by the St. Louis Exposition for the superiority and general excellency of its magnesia steam pipe and boiler coverings; also a gold medal on account of its magnesia flexible cement roofing.

Mr. Edward D. B. Brown has resigned as architect of the Lehigh Valley Railroad Company to accept the position of contracting engineer of Fairbanks, Morse & Company of Chicago. The work on the new repair shops of the Lehigh Valley Railroad Company at Sayre, Pa., on which Mr. Brown has been engaged for the past two and one-half years is practically completed.

Mr. J. P. Neff recently resigned as roundhouse foreman of the Chicago & Northwestern Railway at Boone, Iowa, to enter the service of the American Locomotive Equipment Company, Railway Exchange Building, Chicago. He is a graduate of Purdue University, and, having had about ten years' practical railroad experience, he is a valuable acquisition to this company.

CHICAGO PNEUMATIC TOOLS.—The London branch of the Chicago Pneumatic Tool Company recently transmitted an order for 705 tools. President Duntley, now in England. reports very successful demonstration with the new electric drills. Inasmuch as there is a large field for drills of this kind, it is expected that the business in electric drills will soon exceed that in pneumatic drills.

CROCKER-WHEELER COMPANY.—This company announces that the largest electrical generators in the world driven by gas engines will be furnished by them to the California Gas & Electric Company of San Francisco. Three 4,000 k.w., 3-phase, 13,200 volt, 25-cycle revolving field alternators will be driven by 6,000 h.p. gas engines built by the Snow Engine Company.

Mr. John G. Sanborn, formerly of the Chicago Pneumatic Tool Company, and more recently with the Chicago Storage Battery Company, has accepted a position with S. F. Bowser & Company, Ft. Wayne, Ind., as railway representative for their oil house equipment and oil storage system. Mr. Sanford will make his headquarters in Chicago.